



# ANNALS OF SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

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No. 1

## FRACTURES OF THE LOWER EXTREMITY OR BASE OF THE RADIUS

BY LEWIS STEPHEN PILCHER, M.D.  
OF BROOKLYN, N. Y.

FRACTURE of the lower extremity or base of the radius is one of the most frequent surgical conditions that the medical practitioner has to treat. The writer had his own interest first awakened in it as a boy when one of his playmates fell upon his outstretched hand and was picked up with a "broken and crooked wrist." When immediately after graduation he spent some months in a country district looking for practice, he found it when one of his neighbors fell out of an apple tree and sustained a wrist fracture. Again, when some years later, he essayed his fortune in a city he was helped mightily by a friend who had the misfortune to fall down a flight of icy steps one wintry day, and fractured the base of his radius, and by a boy in his neighborhood who, while flying a kite from the roof of a shed, forgot himself, walked off the roof, fell to the ground and wrenched off the lower epiphysis of his radius with extreme displacement. (The condition of this wrist twenty years later is shown in Fig. 110, *q.v.*).

In a service as attending surgeon in the Outdoor Department of a large hospital, which I enjoyed for a period of ten years, 1873-1883, fractures of the base of the radius formed a constant item. The interest thus awakened in that particular injury led me to give to its observation and study much care. Beside a perusal of the literature of the subject, many dissections and experiments on the cadaver were made; specimens in the museums of various hospitals were freely placed at my disposition by their curators for study. In particular a visit to the collection made many years before by Robert William Smith in Dublin, on which was based the treatise of that surgeon on "Fractures in the Vicinity of Joints," was instructive. In the early part of 1878 I published my first paper (*Reason vs. Tradition in Treatment of Certain Injuries to the Wrist-joint*) on the subject in the *Proceedings of the Medical Society*



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of the County of Kings, and in May of that year had the opportunity of reading a paper on the same subject, and making an experimental demonstration on the cadaver before the New York Academy of Medicine. In May, 1880, I published a "Further Contribution to the Study of Fractures of the Inferior Extremity of the Radius, etc., (*Proceedings of the Medical Society of the County of Kings*, 1880). In the period which has passed since these publications, more than thirty-six years, my interest in the subject has continued, although in the nature of things other departments of surgical work have engaged more of my attention. I am now returning once more to this subject to make a final contribution to it, in which I hope to embody the mature conclusions of these later years. During this period the Röntgen ray has been added as a source of surgical diagnosis and of observation. Upon no subject has it shed a clearer or greater light than upon wrist-joint injuries. It has been a matter of very great satisfaction to me to find that its revelations have been so markedly confirmatory of the conclusions reached before its assistance was enjoyed. As will be seen in the following pages, I have made full use of the wealth of information which the X-ray skiagrams have produced. Many of these were taken by Doctors Cole and Eastmond and by them freely placed at my disposal. The late Carl Beck was an enthusiast both in the matter of X-ray and in the study of fractures of the lower extremity of the radius, and his valuable material was also generously given to me before his death. The X-ray department of my own private hospital has more recently supplemented and extended the studies for which, before, I had to depend on the goodness of my colleagues.

Naturally I have read with interest the chapters devoted to this injury which have been found in the various treatises on fractures that have appeared during the last quarter of a century; the sound and careful studies of John B. Roberts and the brilliant and convincing work of Scudder deserve especial mention among these, but I have not felt that even by these men the last word has yet been said on the subject in question. I am not vain enough to think that I am myself to say this last word, but I am persuaded that there is still some room for further clarifying and systematizing knowledge and teaching in this field, and as an effort in this direction I offer this contribution.

It may be noticed that I do not use at all the name of the distinguished Irish surgeon which for a hundred years has commonly been attached to this injury. I am influenced in this way by two reasons—one, that names descriptive in anatomical or pathological terms of a surgical condition are much to be preferred when it is possible to phrase



FIG. 1.—The base of the radius and the bones of the wrist—skiagraphs of normal bones—*a*, anteroposterior view; *b*, transverse view.

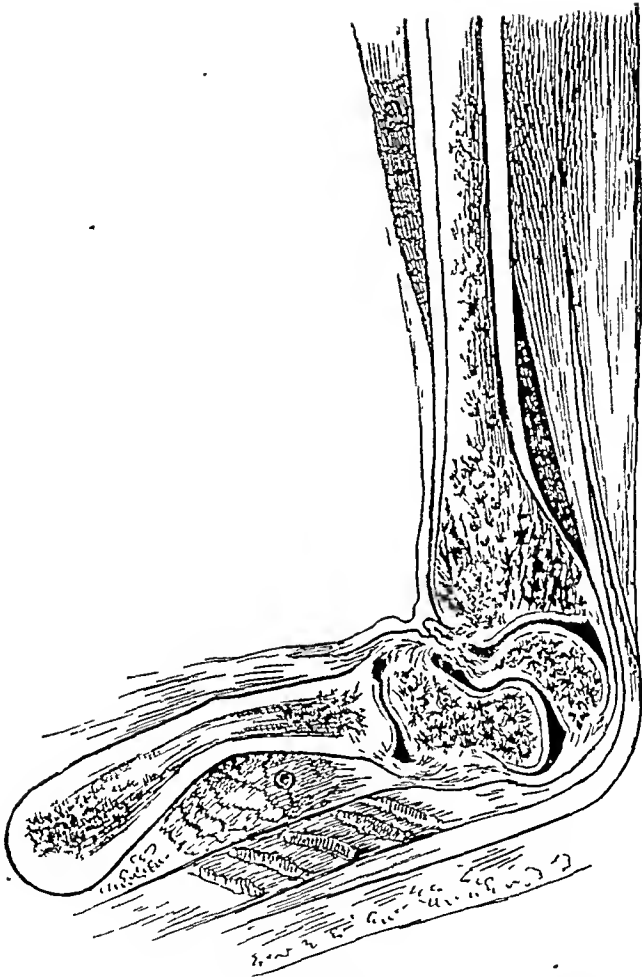


FIG. 2.—Showing relation of the elements of the wrist-joint when the hand is in moderate dorsal flexion (*i.e.*, extension).

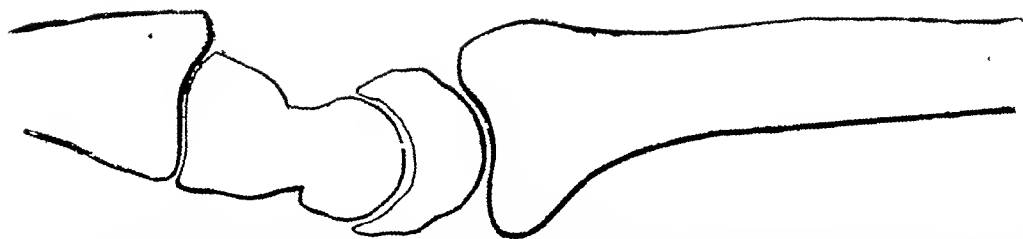


FIG. 3.—Outline from longitudinal section of wrist bones, cut passing through base of radius, semilunar, os magnum and metacarpal bone. Note the projection of the anterior lip of the base of the radius.

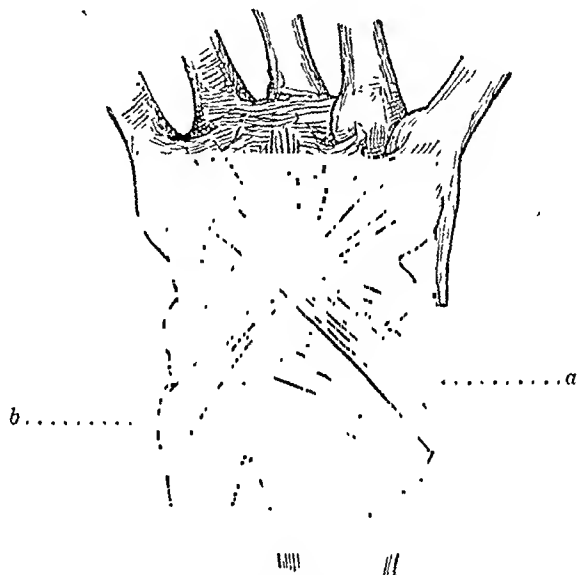


FIG. 4.—Showing the arrangement of the fibres of the anterior common ligament of the wrist-joint. (After Henle.) Note particularly the oblique fasciculi, *a* and *b*, which pass from the mid-carpus outward and upward to be inserted respectively into the styloid process of the radius and of the ulna.

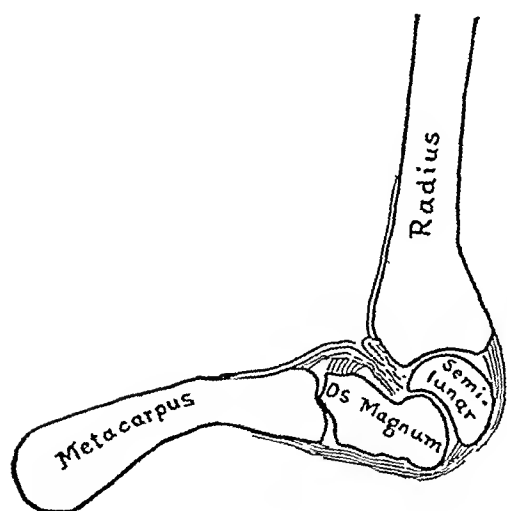


FIG. 5.—Hand in extension: Note the relaxation of the posterior radiocarpal ligament; the rotation and forward projection of the carpal bones, and the tension upon the anterior radiocarpal ligament.

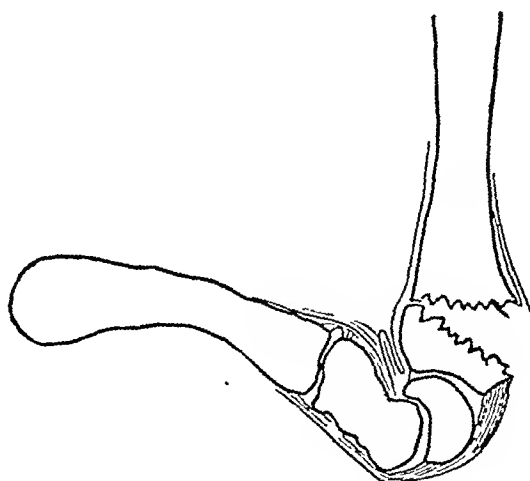


FIG. 6.—Extending force continued: result, extreme backward flexure of the wrist and disruption of the lower end of the radius, the fragment torn off being more or less of that part into which the anterior ligament is inserted.

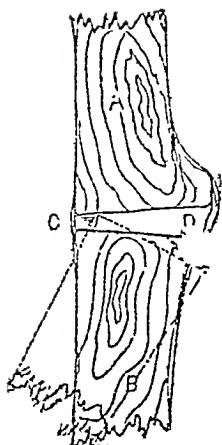


FIG. 7.—The elements of the wrist-joint represented as levers, A and B.

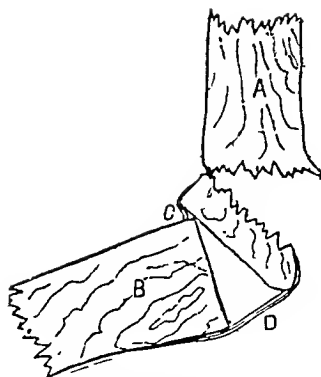


FIG. 8.—Fracture of lever A by cross-breaking strain upon lever B.

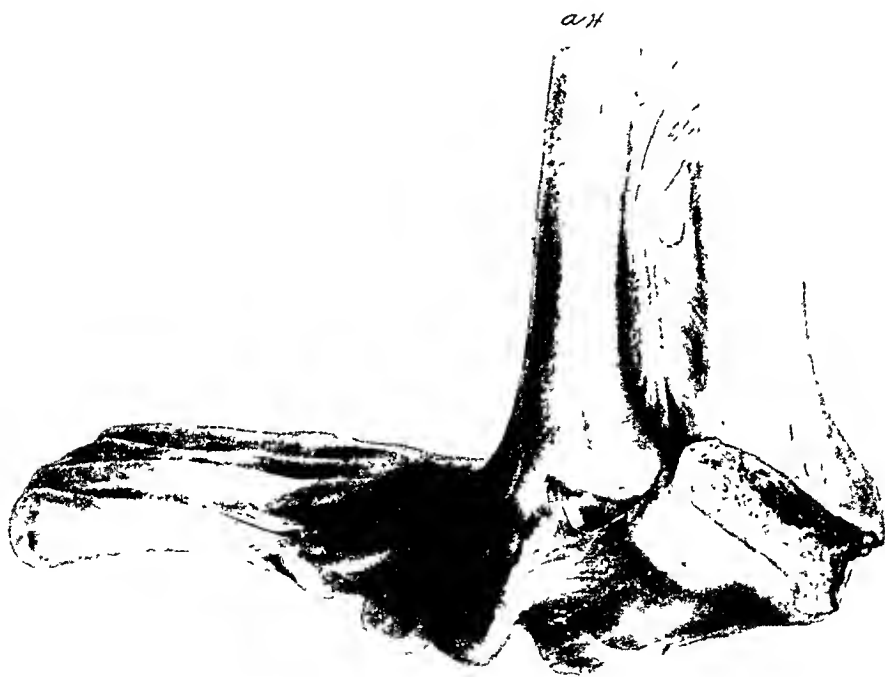


FIG. 9.—The force is transformed into a cross-breaking strain, with the result that the lower end of the bone is torn off (drawing from an experimental specimen.)

them, and, second, because the use of the name in question has been so associated through all these years with erroneous views of the nature and cause of the injury that its continued use tends to hinder the general acceptance now of more accurate knowledge.

That fractures of the lower extremity or base of the radius should be of frequent occurrence one appreciates when the mechanism of its usual production is understood. A fall, and the force of the fall broken by an outstretched arm with hand in extension, are the usual conditions from which it results. In the course of such an accident, forcible bending back of the hand with overtension of the anterior common ligament of the carporadial joint is produced. Strain is brought to bear on the projecting anterior lip of the lower end of the radius (Figs. 2-4). The slipping first row of carpal bones as it moves in the cup-like cavity of the lower articular surface of the radius furnishes the mechanism through which the force is transmuted into a cross breaking strain upon the bone into which the ligament is inserted, with the result that that portion of the bone is torn off (Figs. 5 and 6).

Examine a longitudinal section through the wrist-joint from the middle of the radius to the middle of the third metacarpal bone (Figs. 1-4). The section passes through the semilunar and the outer portion of the os magnum. The carpal bones and the metacarpal are joined together with such firmness that but slight motion is permitted between them. In the movements of extension and flexion at the wrist they act virtually as one bone. At the lower extremity of the radius projects anteriorly a prominent lip, into which is inserted the anterior radiocarpal ligament (Fig. 4), the extent of insertion of whose fibres is continued for a quarter-inch or more above the articular margin. This ligament, though dense and strong, is sufficiently loose to permit considerable latitude of motion backwards of the carpus upon the radius (Figs. 2 and 5). The posterior radiocarpal ligament unites the bones together behind similarly.

The bones thus related constitute two levers. They may be represented as in the accompanying diagram (Fig. 7) by *A* and *B*, held together by bands at *C* and *D*. When *B* is forcibly carried backwards (extension of the hand), the band *D* is made tense; the opposite border of the lever, having slipped forward as far as the band *C* will permit (*cf.* Fig. 2), now abuts against the lower surface *A*, which becomes a fulcrum for the further action of the lever. The mechanical arrangement is such that an immense power may be exerted. If the backward force continues to act, either the band *D* must rupture or a lever be fractured. The projecting lip upon the upper lever puts it at a disadvantage. The

band continues to sustain the strain. The lever gives way (Fig. 8). The point of fracture is necessarily just above that portion of the lever controlled by the band. The strain upon the lever is nearly transverse to its long axis. By this the direction of the line of fracture is determined. A fracture has been produced by definite forces, at a definite point and in a definite direction. These are practically the conditions which unite in the production of the more common fractures of the inferior extremity of the radius.

By the powerful leverage which the extended hand and carpus obtain through the strong anterior ligament upon the lower end of the radius, that portion of the bone is literally torn from it (Fig. 6). The very arrangement of the expanded end, with its cancellated structure, which so admirably fits this portion of the bone for receiving and breaking any shock directly transmitted to it, renders it the less able to resist a force of avulsion. The combination of conditions is such as to make the bone, when submitted to such a strain, weaker than the ligament, and the fracture of the bone accordingly takes place.

*Experimental Demonstration.*—The truth of this may be easily tested experimentally upon the fresh cadaver by simply bending the hand backward strongly, while the forearm is firmly held, until some structure gives way; this will usually be accompanied by a sharp snap. Upon dissection it will be found that as a rule the anterior ligament of the wrist has remained intact, while the radius has been fractured, the line of fracture anteriorly being found rarely at a point higher than a half inch above the articular edge (Fig. 9). In some instances the ligament will be found to have given way and the radius to have remained intact. In some instances where this occurs, a fracture of the scaphoid or semilunar is produced (Figs. 15 and 24). The lower fragment of the radius in those cases where fracture of that bone has been produced will vary in its shape and in the direction of the line of fracture which it presents. This will be found to bear a constant relation to the strength of the different fasciculi which compose the anterior radio-carpal ligament. In this ligament (Fig. 4) three distinct sets of fibres may be traced, the anterior surface of the scaphoid, semilunar and cuneiform bones affording a common origin; one set (Fig. 4) pass obliquely outward to be inserted into the styloid process and the adjoining anterior margin of the lower end of the radius, these form a dense and strong band, the strongest portion of the ligament; a second set (Fig. 4) pass obliquely in the opposite direction and are inserted into the styloid process and anterior margin of the lower end of the ulna; this band is likewise strong and dense; the third set, forming a

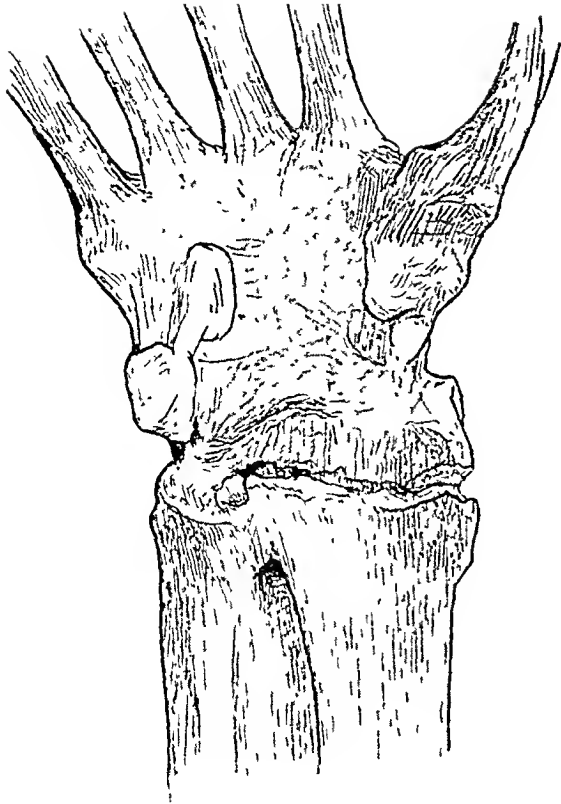


FIG. 10.—Experimental fracture, transverse.



FIG. 11.—Traumatic fracture, transverse.

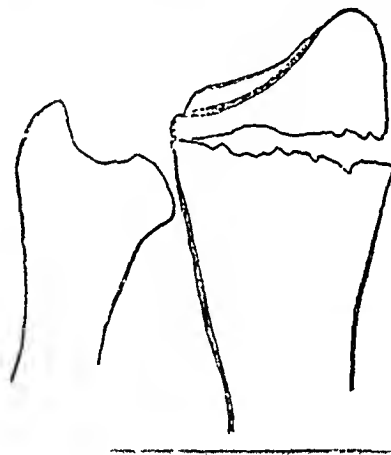
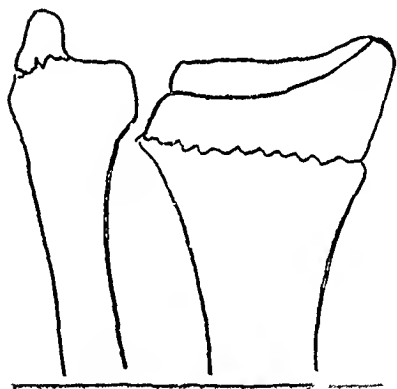


FIG. 12.—Arrow points to line of fracture; lateral view shows radial fragments separated in front, but still held by periosteum behind as by a hinge; angle of separation partly filled with callus. Ulnar styloid fractured.

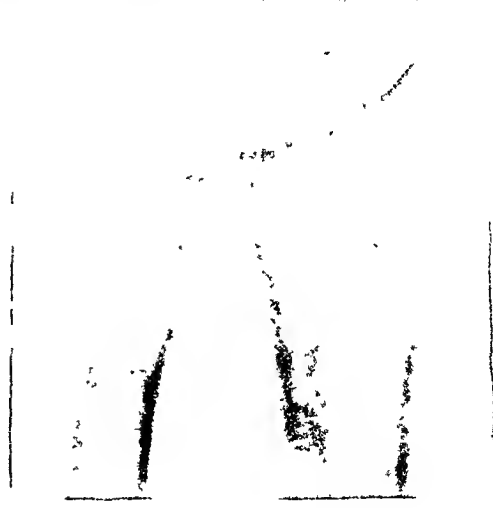


FIG. 13.—Line of fracture somewhat oblique.



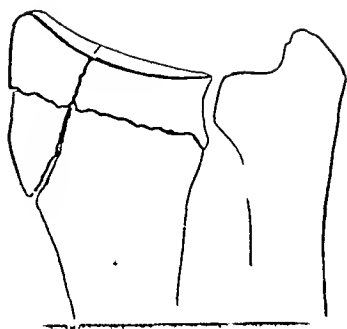


FIG. 14.—A second line of fracture, runs from junction of outer and middle thirds, transverse line upward to base of styloid process. Lateral view shows moderate backward displacement of lower fragments. Mass of callus on dorsal aspect.

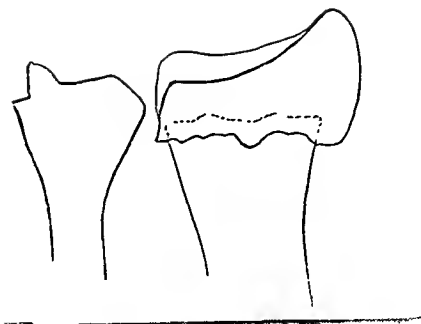


FIG. 15.—Transverse fracture about one-half inch above articular surface. Backward and outward displacement. Fracture of the scaphoid.

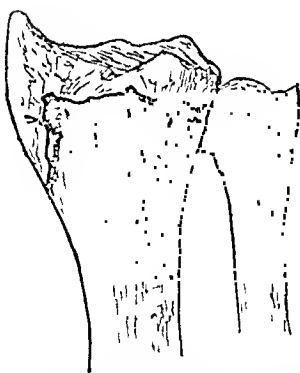


FIG. 16.—Transverse fracture in a man of nineteen years who fell a distance of 40 feet. In front the line of fracture is along the epiphyseal line; thence it runs backward and upward so that on the dorsum the line of fracture is one inch above the articular edge. The lower fragment is comminuted. (Anterior view.) (N. Y. Hosp. Mus. No. 124.)

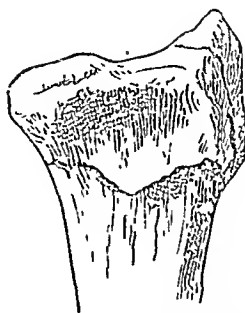


FIG. 17.—Transverse fracture with wedge impaction of upper into lower fragment. Comminution of lower fragment. (McGraw's Case, *Annals Anat. & Surg.*, vol. iii, 116.)

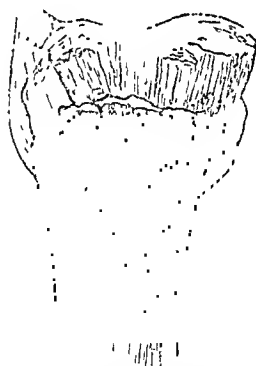


FIG. 18.—Transverse fracture with marked backward tilting of lower fragment. (Anterior view.) (N. Y. Hosp. Mus. No. 123.)

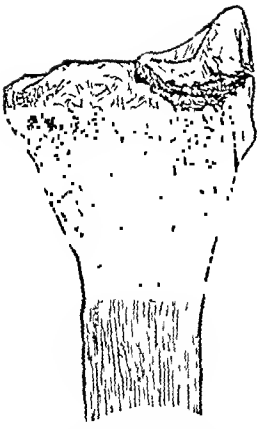


FIG. 19.—Experimental fracture. Central portion of anterior ligament of wrist ruptured.

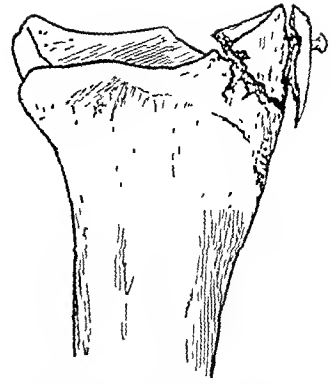


FIG. 20.—Tip of styloid process broken off, scaphoid was also fractured transversely at its middle. Result of fall from top of a derrick (N. Y. Hosp. Mus. No. 125.) See Fig. 34.

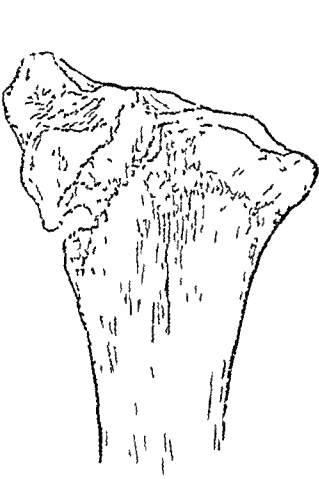


FIG. 21.—Experimental fracture, oblique from centre of carpal surface to base of styloid process.

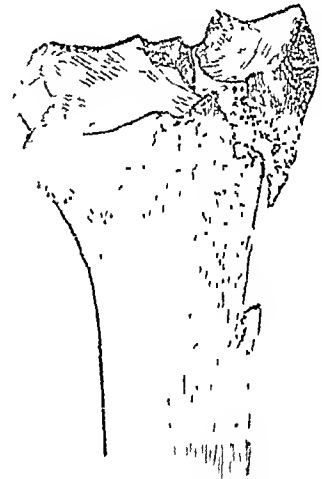


FIG. 22.—Fracture of base of styloid process. (N. Y. Hosp. Mus. No. 127.)

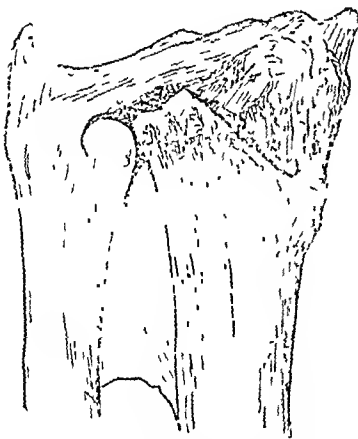


FIG. 23.—Oblique fracture running from junction of inner and middle thirds of articular surface of radius to a point seven-eighths of an inch above tip of styloid process. Lower fragment comminuted. (Anterior view.) (N. Y. Hosp. Mus. No. 122.)

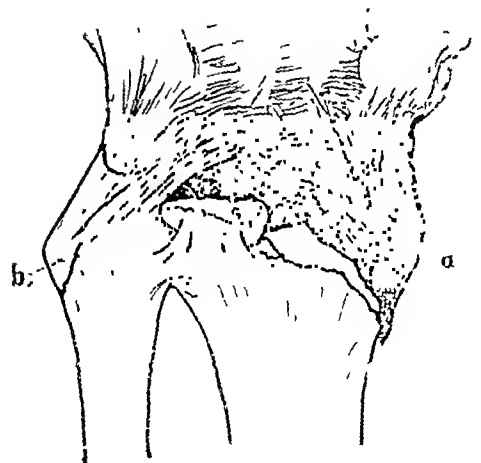


FIG. 24.—Oblique fracture running from ridge on middle of carpal articulating surface to base of styloid process. Transverse fracture of semilunar bone. Fracture of styloid process of ulna. (Wm. Hunt, *Annals Anat. & Surg.*, vol. iii, 112.)

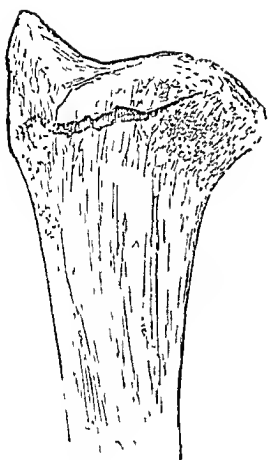


FIG. 25.—Oblique experimental fracture.

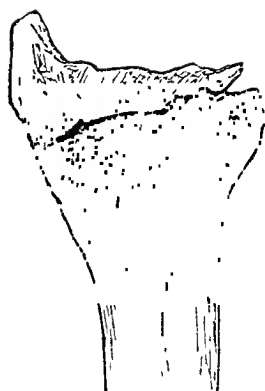


FIG. 26.—Oblique traumatic fracture. (N. Y. Hosp. Mus. No. 121.)

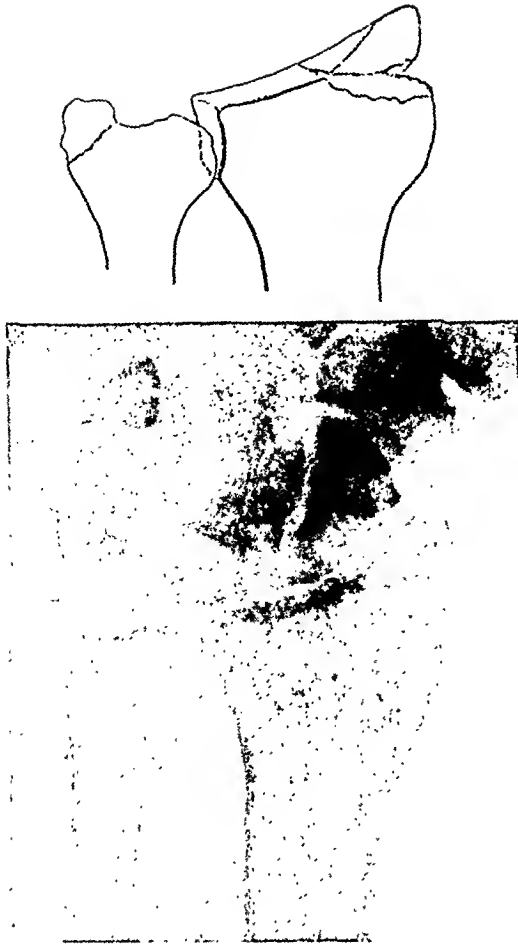


FIG. 27.—Fracture of styloid process of radius and of ulna (automobile crank kickback). Lateral view shows a crush of the posterior lip of the radial articular surface.



FIG. 28.—From middle of carpal articular facet to the base of the styloid process. No displacement.

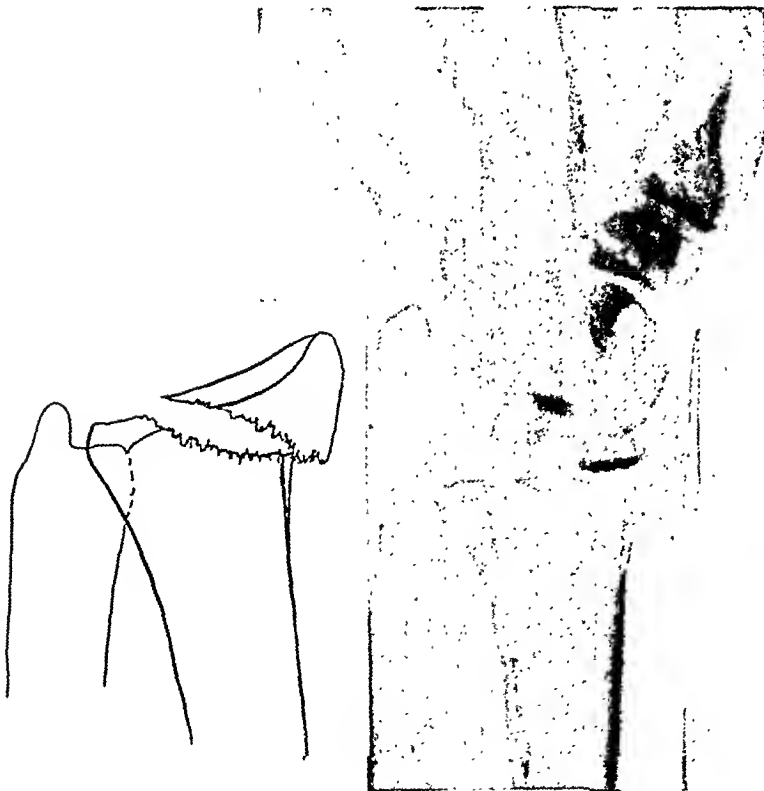


FIG. 29.—Line of fracture begins three-fourths inch toward ulnar side of carpal facet and passes outward with slight obliquity to the base of the styloid process.

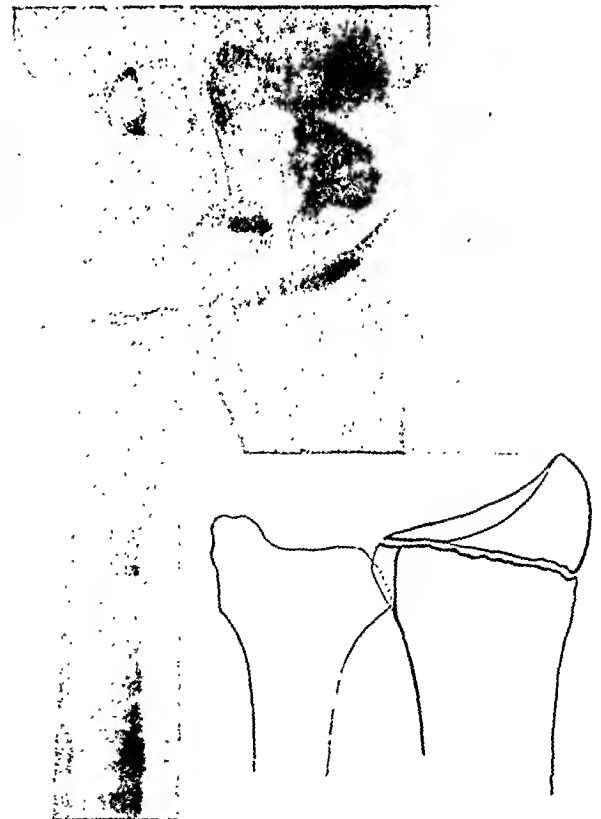


FIG. 30.—Line of fracture from junction of ulnar and carpal facets to base of styloid process. Lateral view shows hiatus between the fragments in front while they are still held together by periosteum behind.



## FRACTURES OF BASE OF RADIUS

broad and less dense band, pass directly upward to be inserted into the greater part of the anterior margin of the lower end of the radius. If both remain untorn—the most frequent condition—the whole of the articular extremity will be torn off, and a nearly transverse line of fracture be produced (Figs. 9–18). If any part of the ligament gives way it will begin from the ulnar side of the middle fasciculus, and only that part of the bone whose attached fibres remain intact will be torn off, producing a very oblique line of fracture (Figs. 19–30), the obliquity running upward and outward from the articular surface to the outer margin of the bone; thus only a bit of the styloid process may be torn off (Figs. 19–22), or a triangular fragment involving the outer half or two-thirds of the articular surface (Figs. 23–30). The variations in the degree of tonicity and thickness of the ligamentous bands, and in the shape of the articular expansion of the base of the radius, and in the arrangement of its constituent bony lamellæ will in the nature of things always more or less modify the results of the avulsive force exercised by the strain on the anterior common ligament of the wrist.

Such experiments upon the cadaver are a more severe test than are the conditions afforded by a fall sustained by a living person, for in the tissues of the cadaver the tonicity of the soft parts present in life is absent and a certain degree of relaxation of the periarticular tissues is present, as the result of which the ligaments which are put under strain must stretch some and so lessen to that degree the power of the cross breaking strain that they transmit to the radius.

Similar experimental tests of the results of forced backward flexion (extension) of the hand in the living are, however, occasionally presented, *e.g.*, the case published by MacLeod in the *British Medical Journal* of July 12, 1879, p. 39. The case was this:

A young man contended with an older and stronger man in a test of strength by placing elbows on a table, interlocking fingers, and then pressing back upon each other, palm to palm. The hand of the young man became violently extended until finally something gave way, with development of sharp pain in the radius and with the well-marked deformity characteristic of fracture of the inferior extremity of that bone.

Or as in another instance under my personal observation, a young woman, while standing on a chair, slipped and falling caught at a table to save herself. The fingers only of the outstretched hand reached the edge of the table, and the result of her effort was to have her hand bent strongly backward. Upon recovering herself she found her wrist was injured. When seen by me shortly afterward a fracture of the lower extremity of the radius was unmistakable.

Or as in this case: A young boy fourteen years of age, while endeavoring to prevent a boat from chafing against a dock, had his right forearm so caught between the boat and the dock that the boat impinged against his elbow while his hand was pressed against the dock. The hand was thus forced into extreme extension. I saw him within an hour after the injury. The right hand presented the characteristic silver fork deformity of fracture of the lower extremity of the radius, and examination revealed a transverse fracture about one-half an inch above the articular surface with backward displacement of the lower fragment.

Or as in the case of a boy of sixteen years, who, while assisting in lowering a box of tobacco down a staircase, had to support for a moment the whole weight of the case upon his extended hands as he attempted from below to prevent it from falling upon him. Immediately he realized that his left wrist had been injured. When I saw him upon the following day I found that the inferior extremity of the left radius was fractured, the line of fracture running transversely less than one-half inch above the articular edge; the lower fragment was slightly displaced backward.

This group of experiences occurred within the space of a few months in 1879 and were recorded by me then. Since that time, however, the extensive use of motor-boats and of automobiles has furnished on a large scale a succession of experimental demonstrations of the effects of overextension of the hand in those frequent fractures of the lower extremity of the radius which have resulted simply from the sudden recoil or "kick back" of the crank of a gasoline explosion engine, by which the hand of the cranker is violently bent backward (Figs. 27 and 59).

*The Force of Impact.*—In the ordinary accidents resulting in a fracture of the base of the radius, other factors additional to that of avulsion enter. The most important of these is that remnant of the forward and downward impulse of the lower end of the radius, a force compounded of the weight of the body and the velocity of the fall which has been sustained, which remains after the force of avulsion, at first exercised by it, is expended.

When the lower fragment of the radius has been torn off it becomes virtually a part of the carpus with which it moves and by which it is carried backward (Figs. 31 and 32).

**FORCES OF CLEAVAGE.**—(A.) *Perpendicular wedge-like impact of the carpus against the articular cup of the base of the radius.* It is conceivable that in the case of a sudden and violent fall the force of which is sustained by the hand, the rounded articular surface of the

FIG. 31.

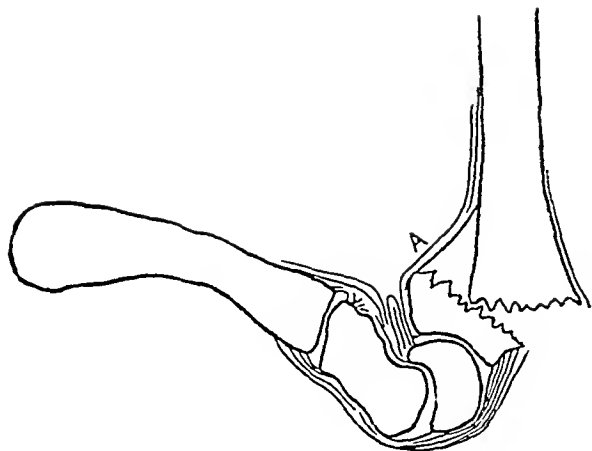
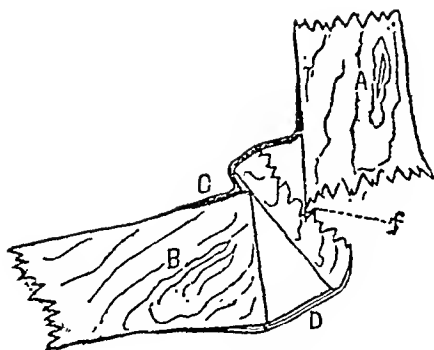


FIG. 32.



FIGS. 31 and 32.—Illustrating mechanism of the backward displacement of lower fragment of radius produced by resistance of wrist and hand resting upon the ground to force transmitted through forearm; periosteum (A) stripped up from back of upper fragment and still connecting the two fragments; impaction of upper into lower fragment probable; hand still in primary position of backward flexion.

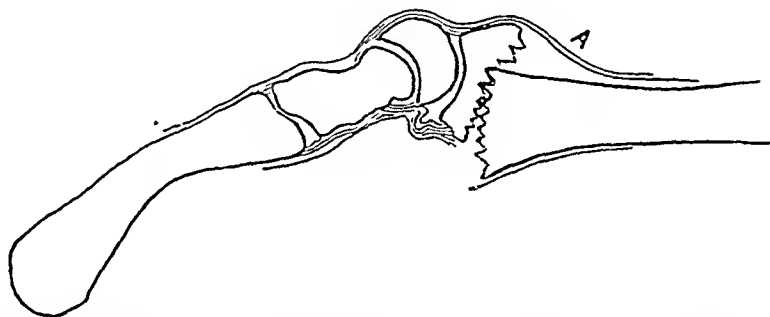


FIG. 33.—Diagram showing position of the parts at the wrist after fracture of the lower end of the radius, with displacement, upon return of hand to natural position. A, untorn periosteum.

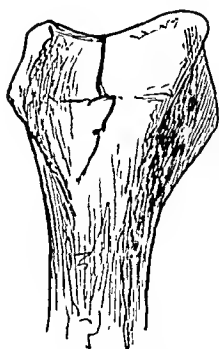


FIG. 34.—Longitudinal fissure running upward from articular facet. Result of fall from top of a derrick. Ulnar aspect of specimen shown in Fig. 20.



FIG. 35.—Longitudinal fissure without transverse fracture. (Bigelow.)



FIG. 36.—Ulnar facet split off by longitudinal fissure. (N. Y. Hosp. Mus. No. 128.)



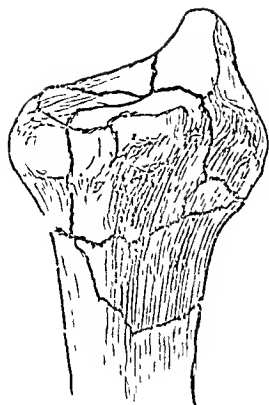


FIG. 37.—Multiple longitudinal fissures of base of radius, result of a fall while walking, in the person of a woman between fifty and sixty years of age. Death on sixth day from pulmonary oedema. No impaction of fragments at time of autopsy. (Personally communicated by Dr. Lewis A. Stimson. Letter May 26, 1881.)

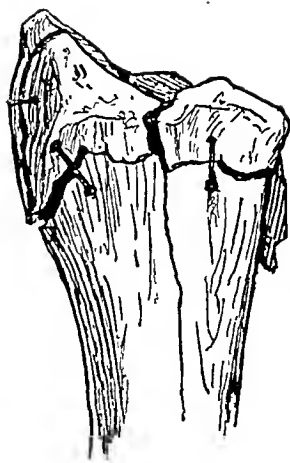


FIG. 38.—Multiple longitudinal fissures of base of radius, from specimen loaned (July 16, 1879) by Dr. Frank H. Hamilton, and received by him from Dr. W. H. Van Buren. Anterior face. For condition of articular face see Fig. 41.

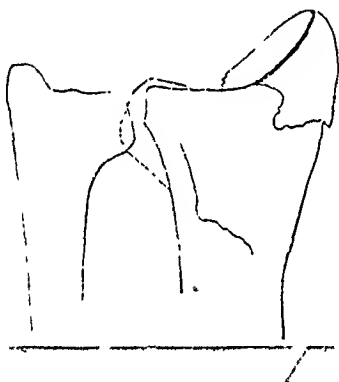


FIG. 39.—Oblique articular fracture complicated by longitudinal fissure through ulnar facet with lines of comminution visible within the carpal facet. Lateral view shows the line of transverse fracture, about half way through the thickness of the bone changes its direction to one running abruptly upwards for one inch, thus splitting away a mass from the posterior lip. This fragment is comminuted.



FIG. 40.—Multiple longitudinal fissures. Posterior face of Fig. 38.

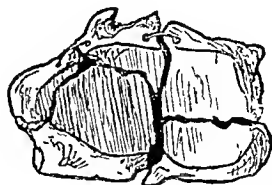


FIG. 41.—Articular face of specimen shown in Figs. 38 and 40.



FIG. 42.—Showing dent in articular cup of radius from impact of carpus.

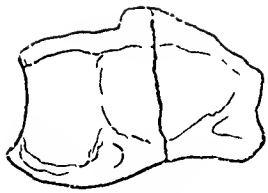


FIG. 43.

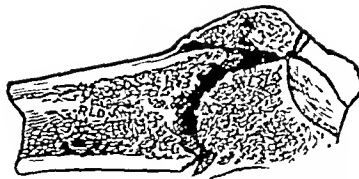


FIG. 45.—Showing manner in which the lower fragment may be split by the penetration into it from above of the upper fragment.

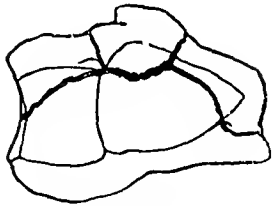


FIG. 44.

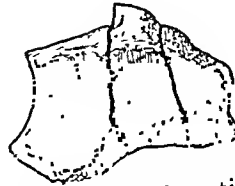


FIG. 46.—Lines of fissure in articular face of carpal cup of FIG. 45.

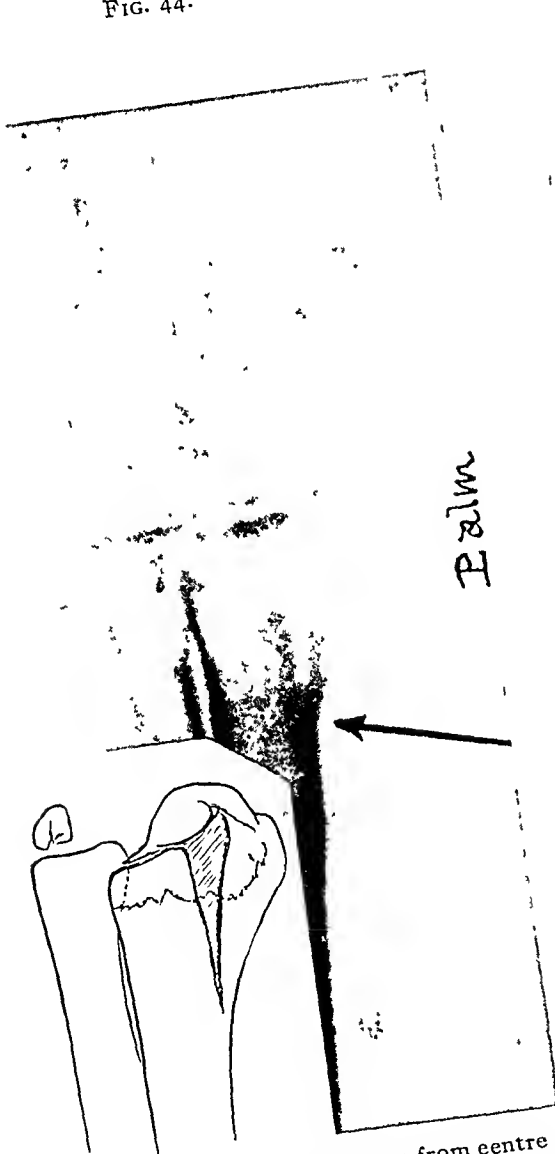


FIG. 47.—Longitudinal fissure from centre of carpal articular facet, running upwards for one inch, where it approaches the palmar surface of the radius (arrow). The lower part of this fragment is displaced forward but above the fragments are held together.

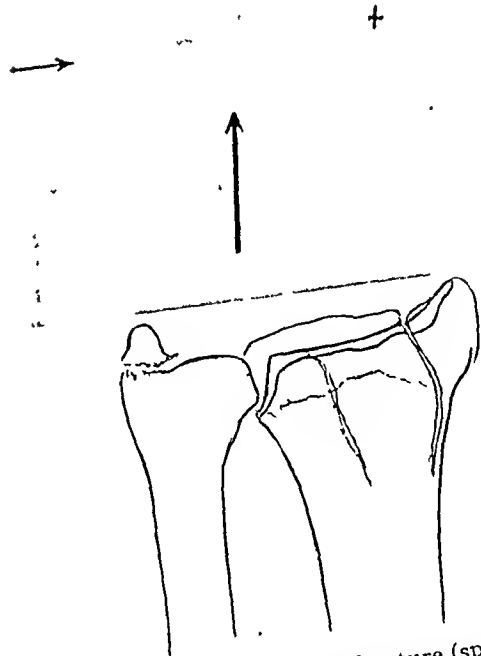


FIG. 48.—Longitudinal fracture (split) of the base of the radius. Line of split (x) visible running transversely along the carpal articular facet, continuing into a fissure running upwards through the ulnar facet (arrow). Ulnar styloid torn off.



FIG. 49.—Longitudinal fracture of the base of the radius (Rankin, *Long Island Med Jour.*, December, 1910).

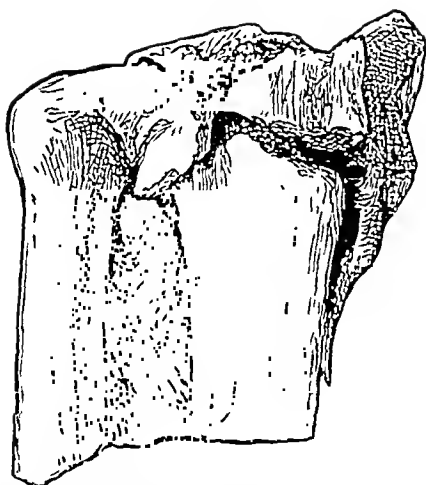


FIG. 50.—Transverse fracture with impaction of upper into lower fragment and comminution of lower fragment. The ulnar styloid is cracked off, but still held by its fibrous envelope. (Roosevelt Hosp. Mus. No. 189.)



FIG. 51.—Line of fracture from upper edge of ulnar facet transversely and obliquely outward and backward. Lower fragment comminuted. For lateral view see Fig. 73. (N.Y. Hosp. Mus. No. 120.)

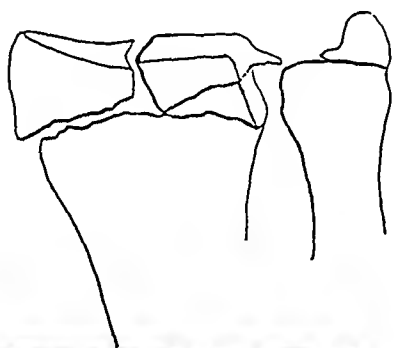


FIG. 52.—Lower fragment comminuted and displaced backwards two-thirds of its thickness as demonstrated in a lateral view. Ulnar styloid broken off.

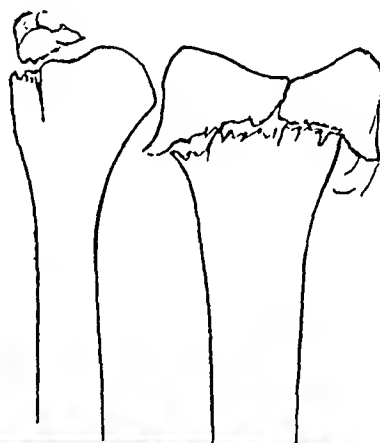


FIG. 53.—Transverse fracture three-eighths inch above carpal edge. Lower end of shaft fragment impacted into articular fragment. Ulnar styloid broken off.

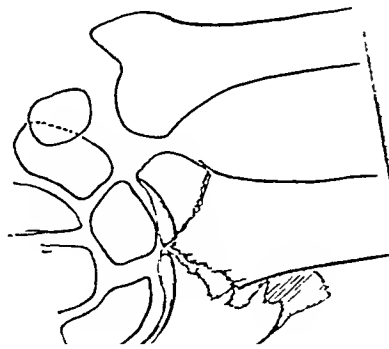
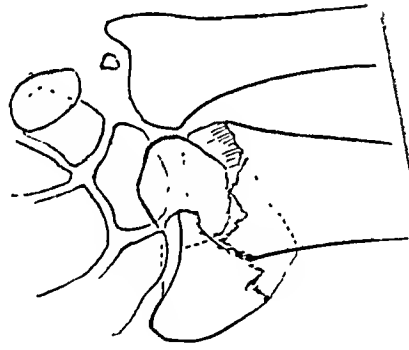
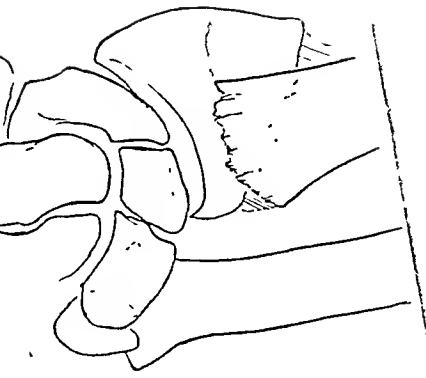


FIG. 54.—Lower end of upper fragment telescoped into lower; marked displacement outwards and backwards of the outer half of the radial articular facet and the styloid process, carrying the wrist and hand with it. Ulna torn from its radial connections.

FIG. 55.—Upper fragment driven into lower fragment, which is comminuted and carried backward and out. upon carpus; ulna styloid torn off.

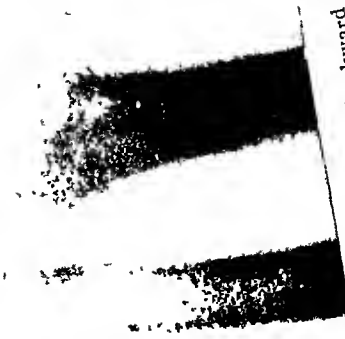


FIG. 56.—Extreme backward and outward displacement of lower fragment carrying outer side between lower and upper; ulna torn away and thrust down on to the inner and posterior aspect of the carpus.

Fig. 57.—Backward and outward displacement with moderate impaction of upper fragment into lower.



Fig. 58.—Lower end of upper fragment driven into lower fragment, most deeply on outer side; lower fragment displaced outwardly (arrow).

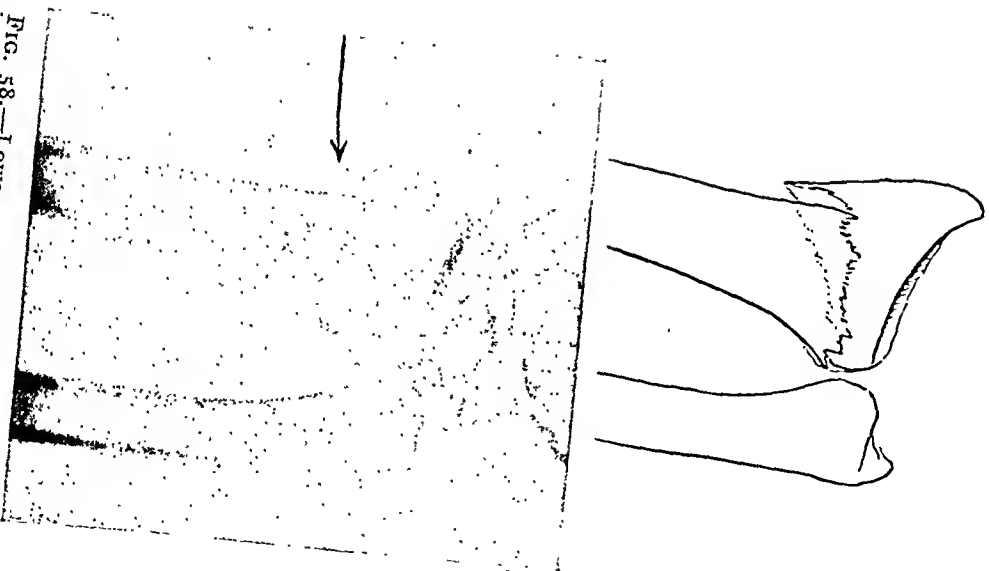




FIG. 59.—Man aged fifty-two years. Transverse fracture, three-fourths of an inch above carpal articular surface. Result of automobile crank kickback.



FIG. 60.—Man aged forty-five years. Transverse fracture, three-fourths of an inch above carpal articular surface, with backward and internal displacement of lower fragment which is comminuted by impaction into it of upper fragment; styloid process of ulna torn off. Head of ulna torn away from its attachment to the radius and thrust downward and outward. Fracture of scaphoid; result of a fall from a ladder. For lateral view see Fig. 95.

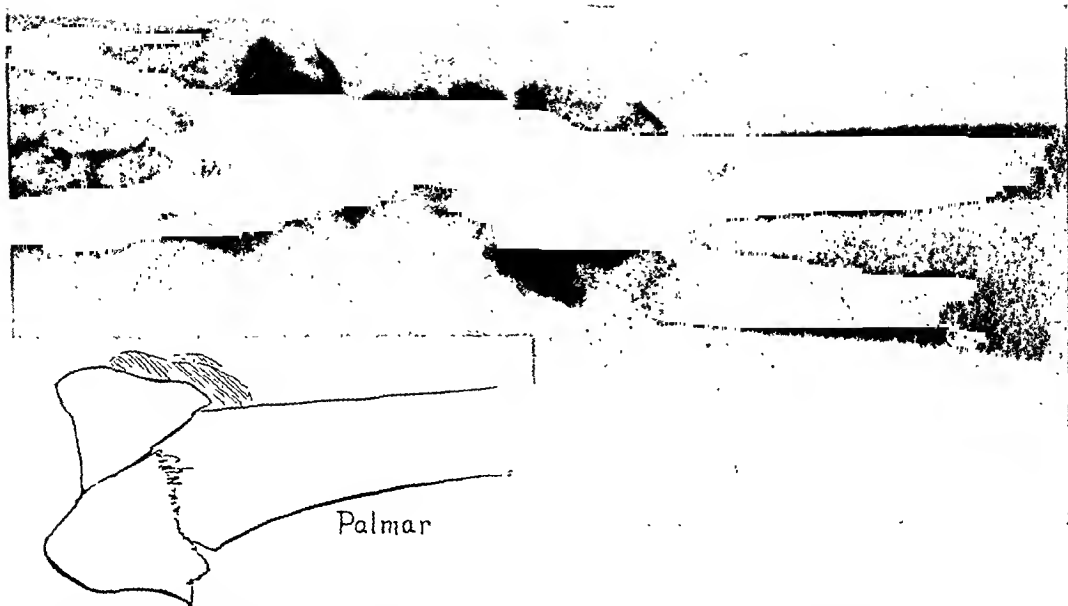


FIG. 61.—Lower fragment split by wedge-like impaction of end of upper fragment. Displacement forward by anterior portion and backward of dorsal portion of the split part. See Fig. 56.

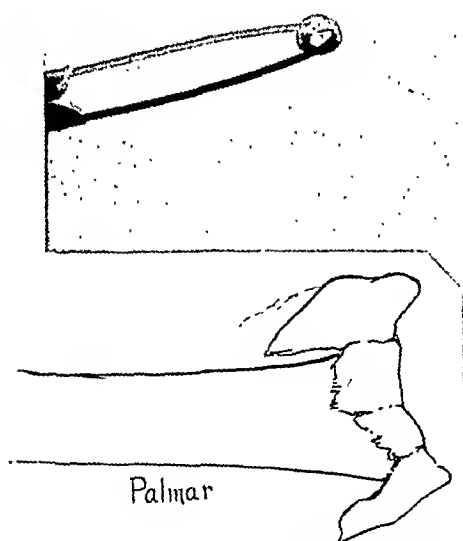


FIG. 62.—Lower end of upper fragment telescoped into lower fragment by splitting it and displacing the fragments backwards, forwards and outwards.



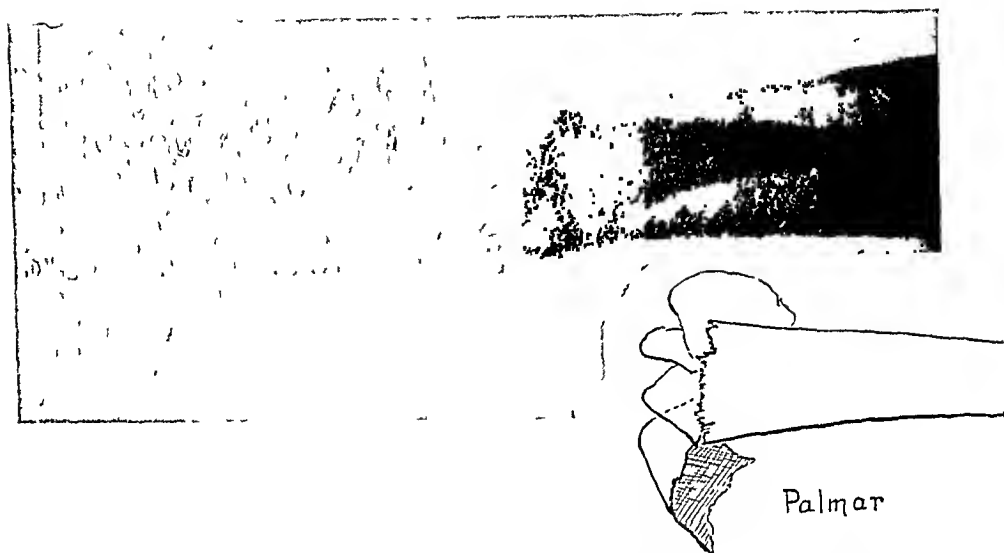


FIG. 63.—Lower end of upper fragment telescoped into lower fragment which is comminuted and mushroomed with fragments displaced both anteriorly and posteriorly. Compare with specimens shown in Figs. 62 and 64.

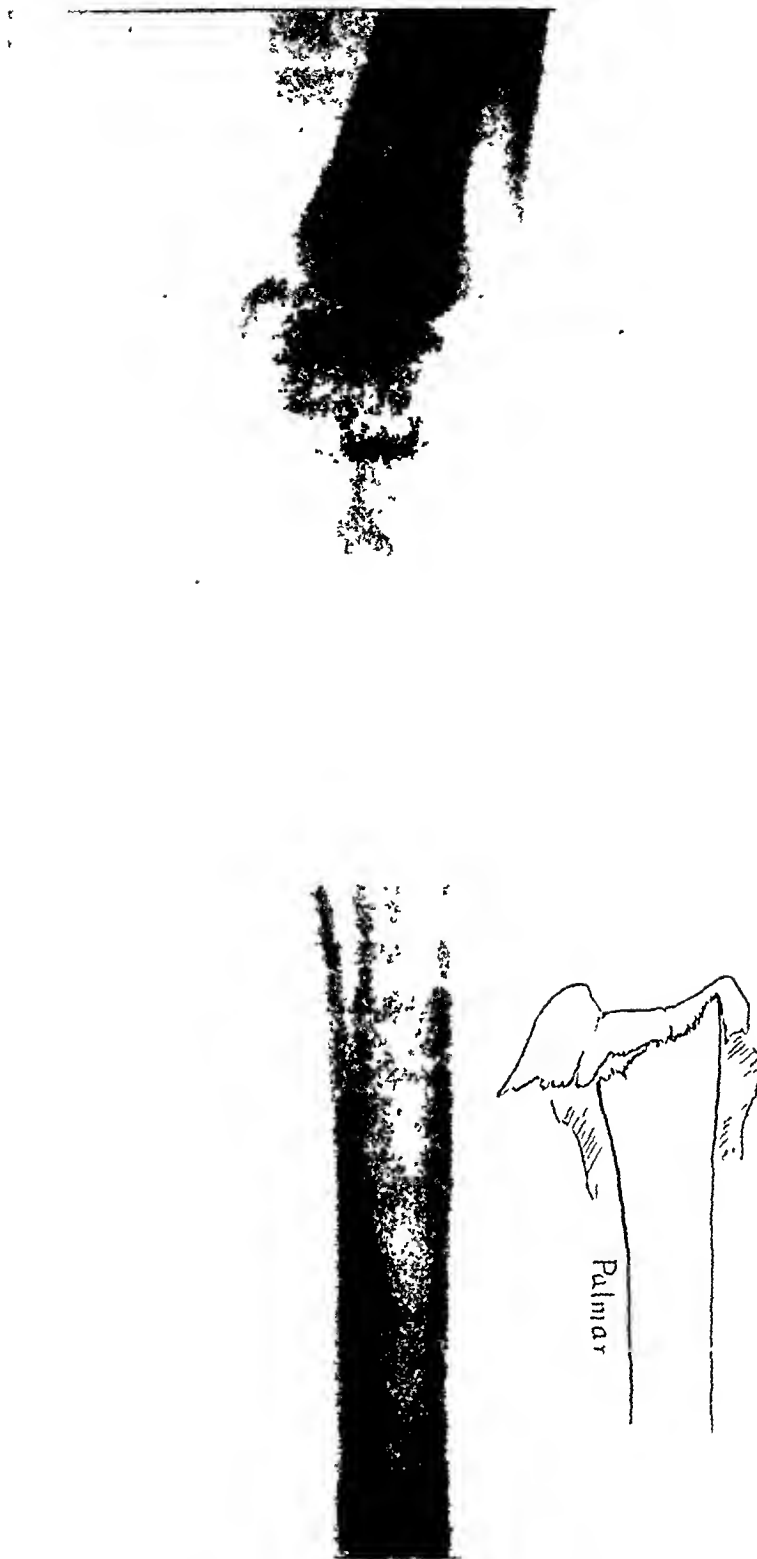


FIG. 64.—Upper fragment telescoped into lower; lower fragment split into many pieces, with anterior displacement of a portion.



## FRACTURES OF BASE OF RADIUS

carpal mass, before the movement of backward flexion is completed, may be driven up against the concave articular surface of the radius with such force as to split it or perforate it and cause stellate longitudinal lines of fracture in the radial base. As a matter of fact, that this does occur at times is proven by post-mortem dissections and in X-ray plates. The action of this force is seen very clearly in Figs. 34 to 49 given herewith, which are from dissected specimens or from X-ray photographs.

(B.) *Splitting of the lower fragment by descent into it of the lower end of the upper fragment.* More frequently, however, indeed very frequently, the lower fragment of the radius is split into fragments by the descent into it of the lower end of the upper fragment or shaft after the transverse lesion has been accomplished. This impaction of the upper fragment into the lower one is generally present when the momentum of the fall has been great, as in falls from a height, and the extent of the impaction is a fair index of the force which the elements of the wrist have had to sustain—the greater the space through which the fall has had its course the greater the velocity attained by which the weight of the body is to be multiplied in producing the resultant force. The friability of the particular bone involved also is a factor that modifies the result in any given case. Falls from a tree, from a ladder, from a second-story window, from a carriage, down a staircase—these are common conditions in which the outstretched hand receives the first brunt of a severe impact upon the ground of the falling body. In this class of cases the lower end of the radius is not only torn off, but as a part of the train of events, absolutely though infinitesimally later in point of time, the upper fragment, if the backward movement of the lower fragment has not been great enough to carry it clear of the broken surface of the upper fragment, is driven into the lower fragment and splits it into secondary fragments more or less numerous.

This splitting of the lower fragment by the descending upper fragment is well shown in Figs. 50 to 55 and 61 to 64. Most instructive also in this connection is a comparison of the two specimens shown, respectively, in Figs. 59 and 60. In both cases the subject was a powerful, large-boned man. Fig. 59 shows the effects of a simple forcible backward flexion at the wrist caused by an automobile crank kick back. The lower end of the radius has been torn off but the displacement has been very slight and there is no tendency to impaction. Fig. 60 shows the effect of a fall from a ladder at a height of ten feet or more above the ground. The lower end of the radius has not only been torn off, but the carpus has been carried markedly backward and outward (see also

Fig. 95 which gives a lateral view of the same case). The lower end of the upper fragment or shaft has been driven into the lower fragment and has split it. The head of the ulna has been torn from its attachment to the radius and has been forced downward and outward. Note particularly the difference in the relations of the ulna to the radius and carpus in the two cases. Finally, the styloid process of the ulna has been torn off.

*Explosive Splitting of Lower Fragment of Radius.*—In the course of the examination of numerous skiagraphs of injured wrists I have observed in certain more rare instances that the usual backward displacement of the upper fragment has not taken place before the denser cylinder of the upper fragment has been driven down into the cancellous tissue of the lower fragment with such force that the pieces into which the lower fragment has been split are driven off in various directions, to the palmar as well as to the dorsal sides. This necessarily causes marked shortening of the radius and outward protrusion of the head of the ulna. Figs. 61 to 64 are examples of this explosive splitting of the lower radial fragment.

*Backward Displacement of the Lower Fragment of the Radius.*—The usual, the typical displacement that characterizes the ordinary fracture of the lower extremity of the radius, is a movement toward the dorsum of the lower fragment. This is the chief cause of the deformity which proclaims the fracture (Figs. 65–68). The carpus as it is pressed upwards and backwards by the impact of the fall tends to carry with itself the fragment of the radius which has been torn off, and the extent to which such displacement may go is limited only by the resistance of the fibrous bindings that hold the parts together and the magnitude of the force that the fall has produced (see Figs. 31, 32, 33 and 68). Various degrees of this backward displacement are shown in Figs. 69 to 98, inclusive. In the bones shown in Figs. 76 and 77, the lower fragment is seen to have been torn from the shaft and moved downward and backward on its palmar side, while its posterior edge is still held by the periosteum as by a hinge. The result is an anterior gap in the radius which has later been filled with callus, and thus the plane of the carpal articular surface has been materially and permanently changed. The same condition of incomplete tearing away of a thin scale from the base of the radius, the fragments being still held together on the dorsum, is well shown in Figs. 81–83. In Fig. 80, *A, B, C*, an outline in red of a normal radius has been superimposed on the outline of the injured radius (Figs. 76, 77 and 79) to show this alteration in the plane of the carpal articular surface produced by the



FIG. 65.—Deformity of wrist due to fracture of the base of the radius with moderate backward displacement of the lower fragment.

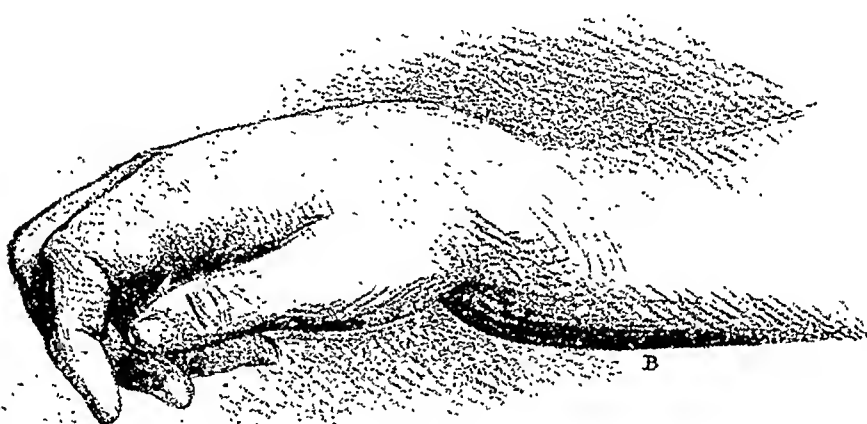


FIG. 66.—Typical silver-fork deformity caused by fracture of lower extremity of the radius, with moderate backward displacement of the lower fragment.

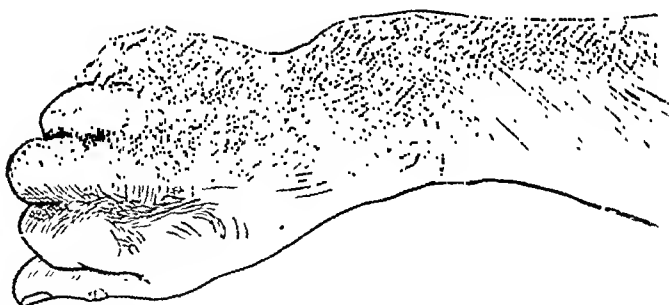


FIG. 67.—Showing bend of wrist to radial side, projection of ulna; external appearance of the wrist from which the specimen shown in Fig. 24 was obtained.

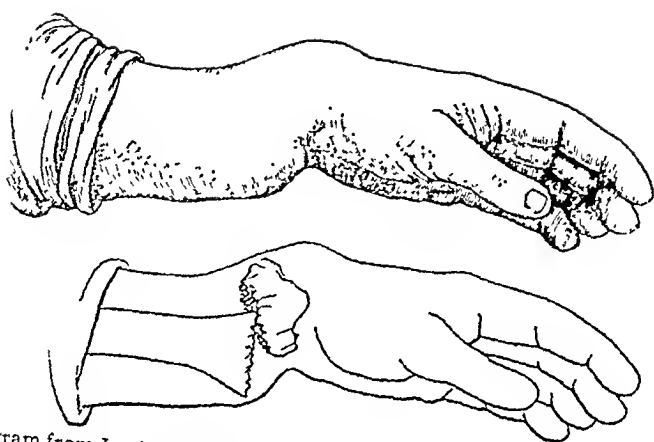


FIG. 68.—Diagram from Levis to show relations of bony displacement to external deformity.

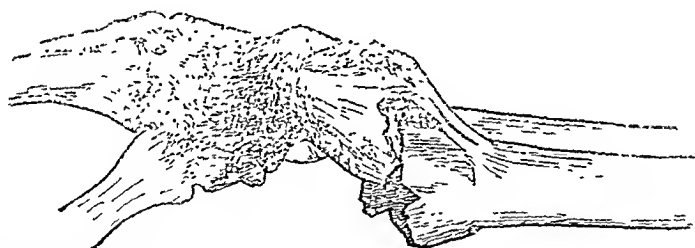


FIG. 69.—Note posterior displacement of lower fragment without impaction; stripped up periosteum still forms a band uniting the upper and lower fragments and holding them in their new relations.

Palmar surface

—Tip of ulnar sty-  
loid broken away



FIG. 70.—Typical fracture by avulsion of the lower end of the radius with moderate degree of backward displacement of the lower fragment and slight impaction of upper into lower fragment; tip of styloid process of ulna torn off. Note angle on posterior aspect filled up with callus. Note sharp projection of the anterior edge of the upper fragment which irritated and disabled the palmar flexors.





FIG. 71.—Showing relations of elements of wrist-joint following backward displacement of torn-off fragment of radius; hand in position of force : dorsal flexion.

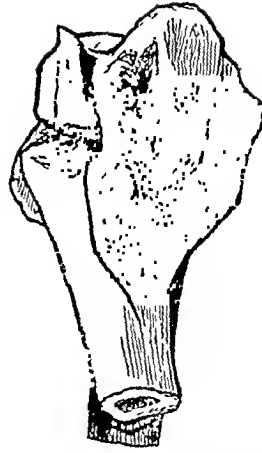


FIG. 72.—Demonstrates well the intact state of the posterior periosteum and fasciæ which is stripped up from the back of the shaft for an inch with backward tilting of the lower fragments.

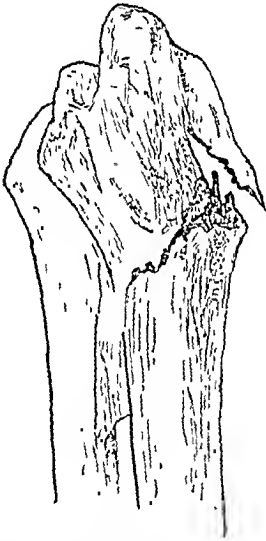


FIG. 73.—Transverse fracture (see Fig. 51) with fragments separated in front, but held together behind by periosteum, resulting in backward tilting of the lower fragment. (N. Y. Hosp. Mus. No. 120.)

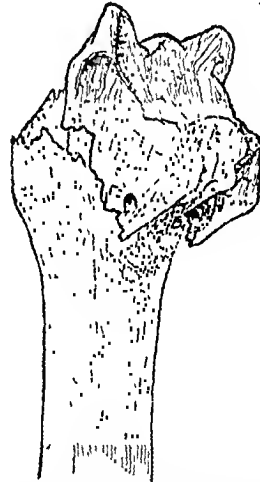


FIG. 74.—Complete detachment of lower fragment with marked backward displacement and tilting. Lower fragment entangled upon serrated posterior edge of upper fragment. (N. Y. Hosp. Mus. No. 123.)

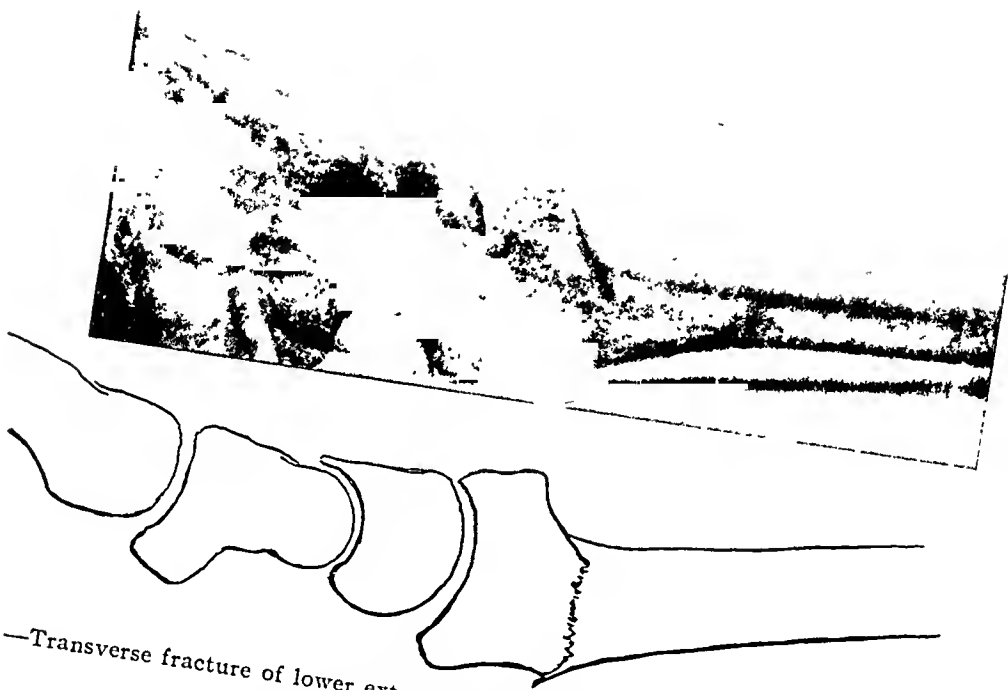


FIG. 75.—Transverse fracture of lower extremity of radius, backward displacement of the lower fragment, with impaction.

FIG. 76 —Lower fragment torn from upper in front but still attached behind by periosteum. Callus fills up the angle of separation in front. Note the alteration in the contour of the base of the radius and the changed plane of the carpal articular surface.

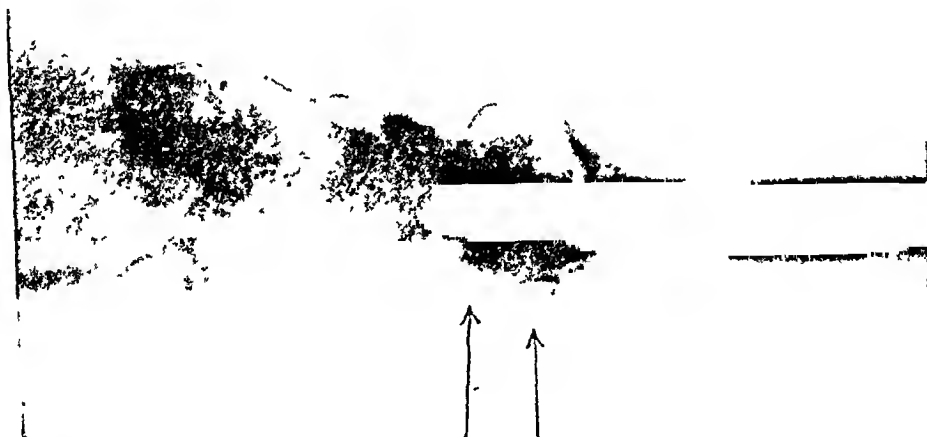


FIG. 77.—Line of separation anteriorly indicated by arrows; lower fragment displaced backwards and canted over and entangled upon posterior edge of upper fragment—slight impaction. Note mass of callus filling up angle behind.



FIG. 78.—Loss of anterior projection of palmar lip of articular surface of base of radius, result of fracture. (See Figs. 79 and 80.)



FIG. 79.—Old healed fracture of the base of the radius in which there has been backward bending of the lower fragment without displacement of the posterior bony lamellæ; the plane of the articular facet is changed (see Fig. 115); the lower palmar surface is flattened by the loss of the projection normal to the anterior articular lip (Fig. 114). The changed contour is suggestive of an original break similar to that shown in Fig. 70, *q.v.* Specimen obtained from a dissecting-room cadaver.

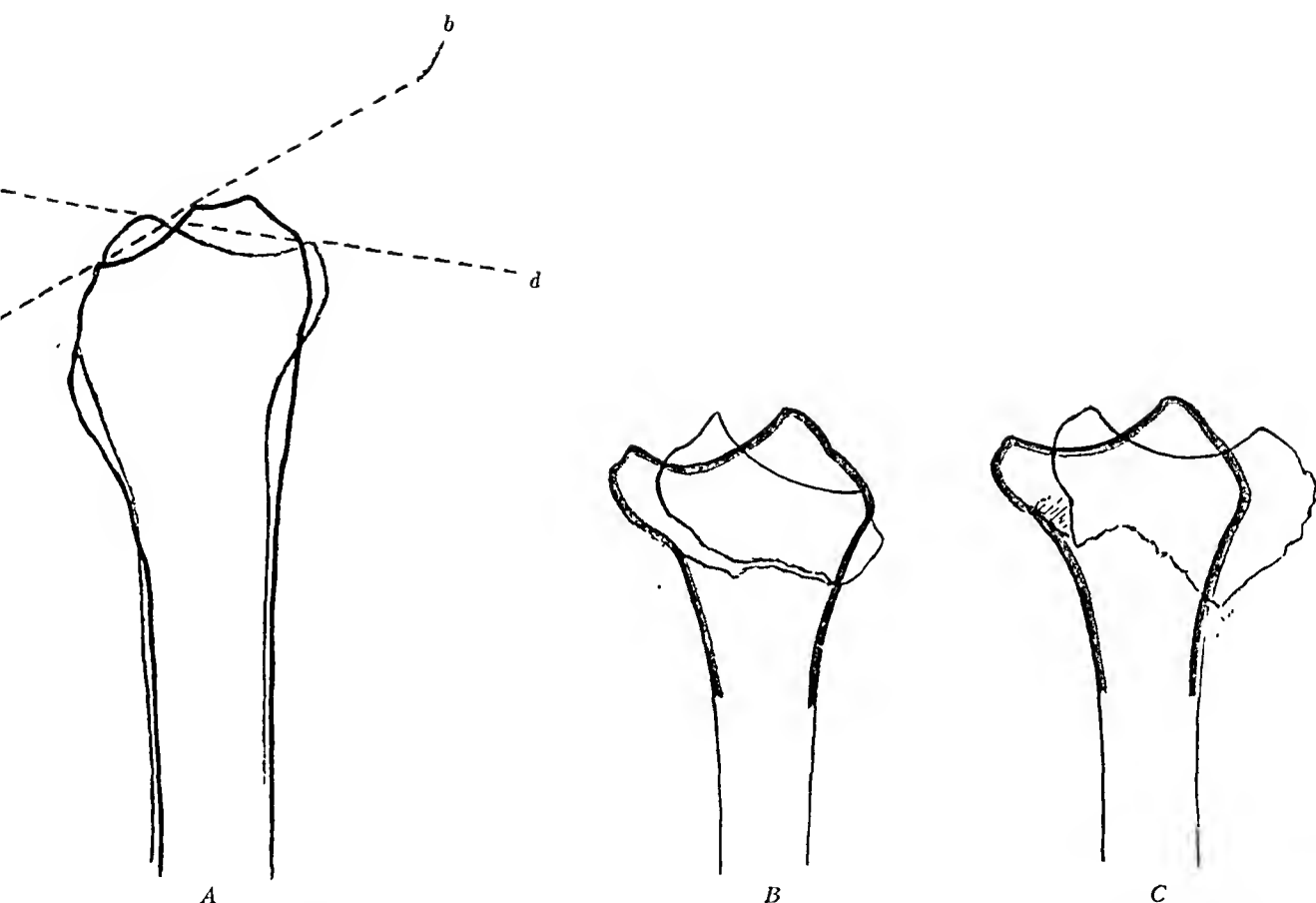


FIG. 80.—Outlines of the lower ends of fractured radii constructed from the specimens shown in Fig. 79 (*A*), Fig. 76 (*B*) and Fig. 77 (*C*). On these are superimposed outlines in red showing the normal contour of the base of the radius (see Fig. 1). In *A*, the dotted line *ab* indicates the plane of the articular surface of the injured bone; the line *cd*, that of the normal bone. The change in the plane of the carpal articular surface of the radius even in minor degrees of displacement is unmistakable.



FIG. 81.—Incomplete fracture. Arrow-head points to line of fracture. Note the change from the normal of the plane of the carpal articular surface. Deformity negligible.



FIG. 82.—Fragments separated in front (arrow); moderate impaction of upper into lower fragment behind; no marked posterior displacement; plane of carpal articular surface changed.



FIG. 83.—Anterior projection of radial articular lip preserved; line of fracture begins in the anterior edge of the articular lip and at a point half way to the back runs abruptly upward, splitting away a mass from the posterior lip of the radius. This fragment is comminuted.



FIG. 84.—Lower fragment displaced backwards with impaction into its substance of the lower end of the upper fragment. Note particularly the sliver of bone which suggests the tearing up of the posterior periosteum which covers it. Note the sharp line of separation anteriorly.



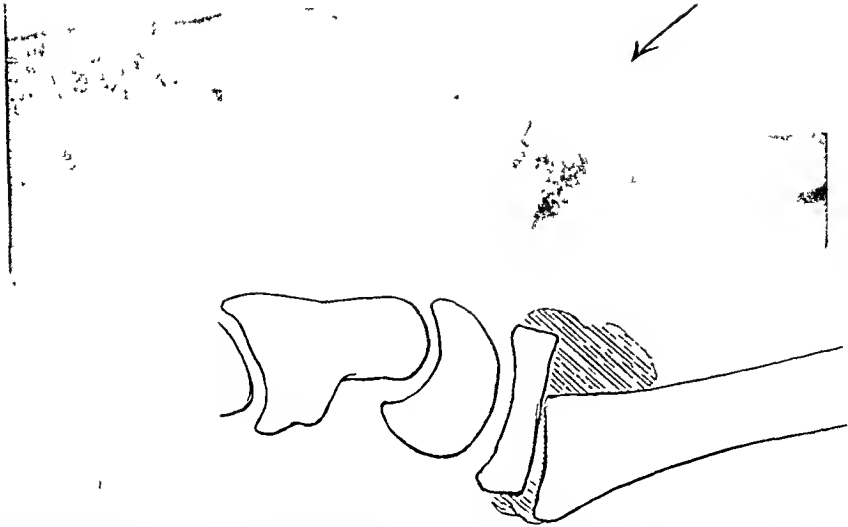


FIG. 85.—Epiphyseal separation in a thirteen-year-old child: backward displacement of lower fragment, periosteum torn up and angle beneath periosteum filled with callus. See Fig. 109.

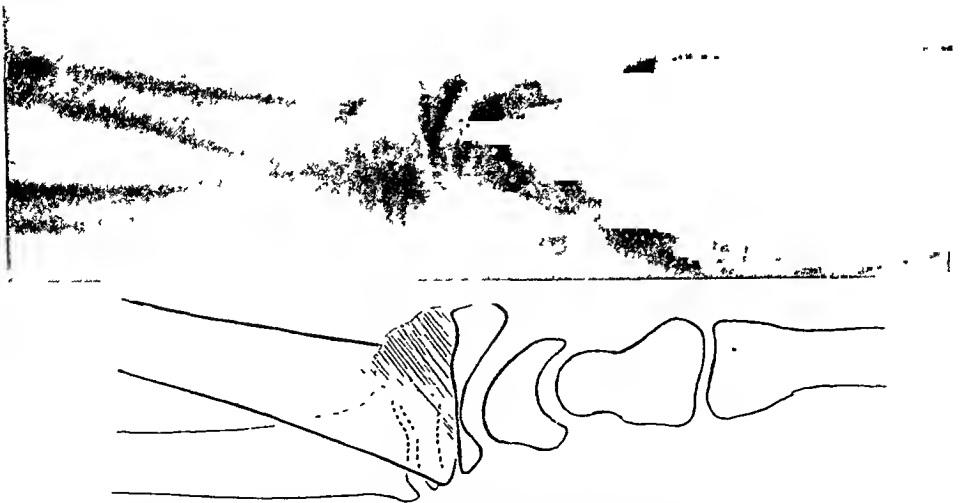


FIG. 86.—Epiphysis displaced backwards; angle on dorsum filled with callus. (Lateral view, see Fig. 106 for anteroposterior view.)



FIG. 87.—Fracture of radius seven-eighths of an inch above carpal articular surface (typical "Colles's fracture"). Lower fragment displaced backward and entangled on lower end of upper fragment.

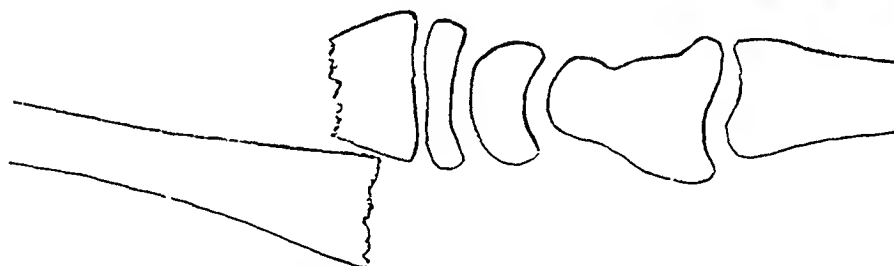
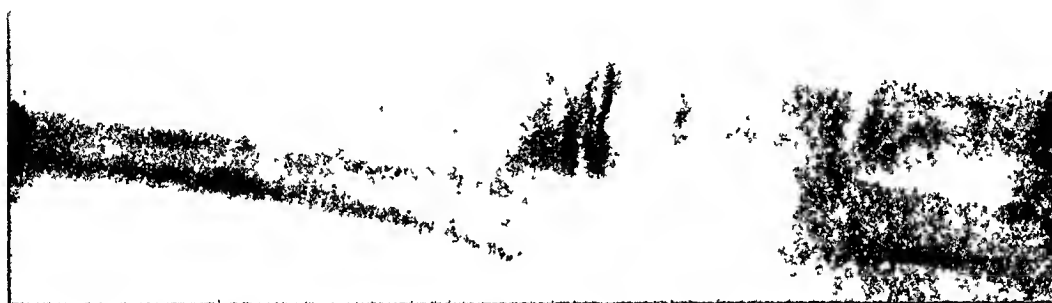


FIG. 88.—Extreme backward displacement of lower fragment, overriding the dorsum of lower end of upper fragment. Lateral of Fig. 96.

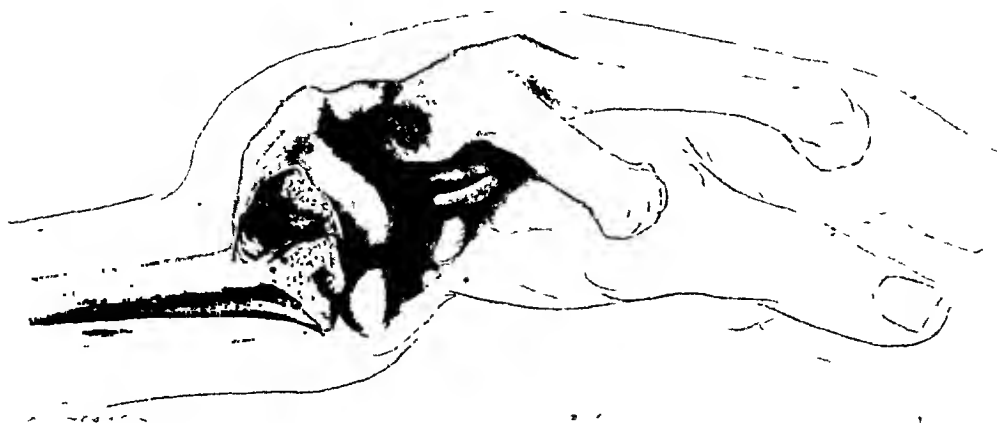


FIG. 89.—The broken-off lower fragment of the radius has been carried so far back that it lies entirely posterior to the upper fragment, the lower end of which it overrides (experimental fracture).

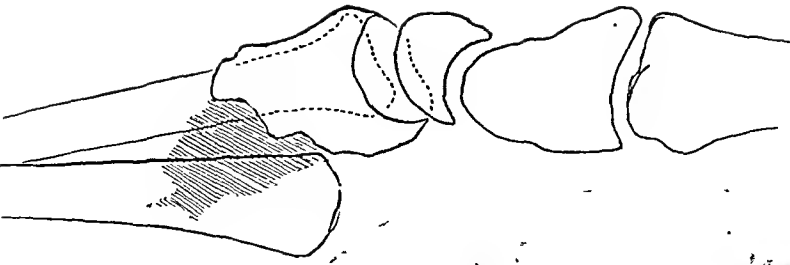


FIG. 90.—Extreme posterior displacement of lower fragment of radius, carrying with it the ulna and carpus. Lower end of upper fragment projects strongly in front. Lateral of Fig. 91.

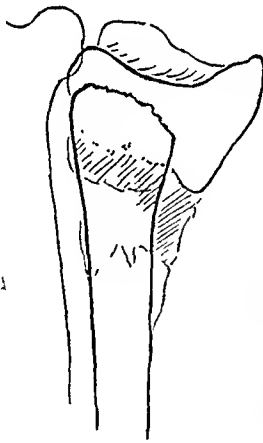


FIG. 91.—Complete displacement backwards and outwards of lower fragment produced by playing hand ball six weeks after primary injury, in a youth of seventeen years. For lateral view see Fig. 90.



FIG. 92.—Extreme backward and outward displacement of lower fragment carrying carpus and hand. Ulna torn from its radial attachments and its head thrust down on the inner side of carpus. For lateral view see Fig. 94. Old injury.



FIG. 93.—Marked backward displacement of lower fragment; entanglement without impaction of lower on upper fragment. Note unbroken periosteal bands.

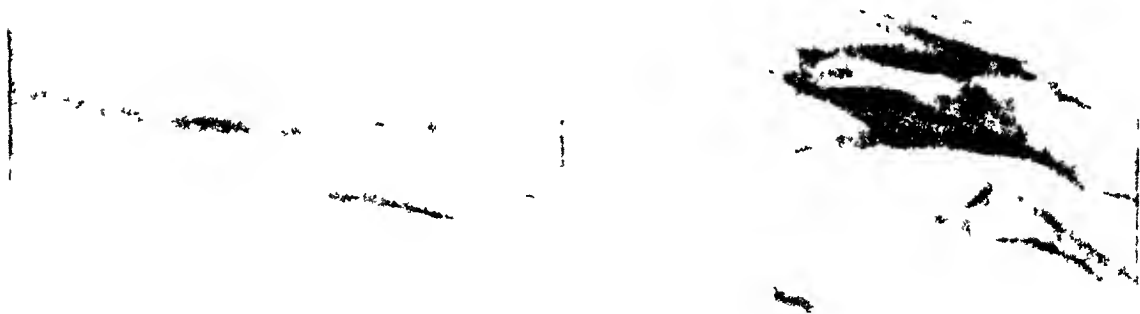


FIG. 94.—Extreme posterior displacement; skiagraph taken many years after the injury. Lateral of Fig. 92.

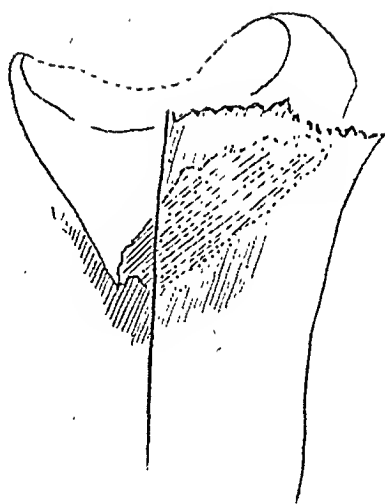


FIG. 95.—Obliquely lateral view of a wrist injured by a fall from a ladder. The lower fragment of the fractured radius is displaced backward and comminuted by the penetration into it of the lower end of the upper fragment. The head of the ulna is forced downward and forward, and its styloid process has been torn off. For anteroposterior view see Fig. 60.

## FRACTURES OF BASE OF RADIUS

injury. If one bears in mind the normal outline of the base of the radius (Fig. 1) the changes in its contour resulting from the ordinary fracture will readily be appreciated and the reason for the change will be understood and what can or cannot be done by treatment in the way of restoring the normal condition of the wrist may be demonstrated.

In the ordinary fracture, occasioned by a moderate force, the backward movement of the lower fragment is arrested before the fragment is carried to a plane entirely beyond that of the end of the shaft above. This is always the case where impaction of the one into the other is present. In many cases, however, this interlocking of the two fragments cannot properly be called an impaction, but is rather to be described as an entanglement of the irregular and serrated surfaces of the fracture masses into the irregularities one of the other. Figs. 69 to 87, inclusive, illustrate this lesser degree of displacement.

In Figs. 88 to 95 the most extreme degree of backward displacement is shown. The broken off lower fragment of the radius has been carried so far back that it lies entirely posterior to the upper fragment, the lower end of which it overrides. Such a degree of displacement, although not common, is by no means rare of occurrence. The case depicted in Figs. 90, 91 and 92 has this interesting and instructive history:

A young man had sustained an injury to the wrist in the usual way without marked displacement; its full character was not appreciated and at the end of three weeks he had so far recovered that he ventured to indulge himself in a game of "hand-ball," a game in which the hand is continually thrown into violent extension in receiving and returning the ball. In the course of the game his injured wrist suddenly displayed an extreme degree of disability and deformity. A skiagraph then taken revealed the condition shown in the figures. It was evident that a fracture without displacement had taken place three weeks before and that now in the course of the repeated violent hyperextensions of the wrist called for in the playing of the game, the newly formed callus bond had given way and the final marked displacement had occurred.

*Outward Displacement of Lower Fragment.*—The immediate effect of the giving way of the radius and the backward slipping of the carpal fragment is a movement of rotation, in the direction of supination, of the carpal mass around the head of the ulna. Not infrequently the strain upon the carpo-ulnar ligamentous fibres (Fig. 4, *b*) is so great that the styloid process of the ulna is torn off (Figs. 24, 27,

47, 48, 52, 53, 56, 60, 70, 95, 104). The broken lower end of the shaft of the radius is thrust forward and the expanded lower articular fragment is made to appear to have moved laterally. This is seen very clearly in such Figs. as 54, 55, 56, 60, 89, 91, 92, 95, 96, 97, 98). There is undoubtedly some lateral movement but the chief element is the one of supinating rotation which brings the lower fragment into lateral relief. The lateral movement is also well shown in the specimen represented in Fig. 97, which is an old healed fracture found in a dissecting room subject. The slightest suggestion of it is visible in Fig. 59, a case in which there was a minimum displacement of the fragments.

I have, however, seen one case in which fourteen weeks after a fracture of the base of the radius had been manipulated by a surgeon in the effort to reduce the fracture the lower fragment was still on the dorsum of the upper one but had been displaced laterally toward the ulnar side, quite the opposite displacement to that usually present. I attributed the unusual character of the displacement to the hand having been kept strongly flexed laterally to the ulnar side while consolidation of the fracture was taking place, while at the same time the dorsal displacement was left unreduced. The styloid process of the ulna was torn off and the scaphoid bone fractured transversely at its middle. Much disability and pain still persisted. The accident was caused by an automobile crank kick-back.

*Anterior Displacement of the Lower Fragment.*—In falls upon the wrist with the hand in forward flexion it would seem theoretically possible that the lower end of the radius might be torn off, even as it is in the position of extension or backward flexion, although the mechanical conditions from the anatomical configuration of the lower end of the radius are much less favorable for the production of a force of avulsion. The rarity with which a fall is sustained by the hand with the wrist in flexion is so great that the occurrence of the accident in question is much less frequent than is the fracture with the wrist in extension.

As long ago as 1847, R. W. Smith, of Dublin, in his work on "Fractures in the Vicinity of Joints," p. 162, described this condition, based upon a case in which the lower end of the radius was broken and driven forward along with the carpus as the result of a violent fall upon the back of the hand. In 1896 this particular accident was made the subject of careful study by John B. Roberts, of Philadelphia, who collected a number of histories and described specimens in which the condition exists (*Transactions of Amer. Surgical Assn.*, 1896, xiv, 611).

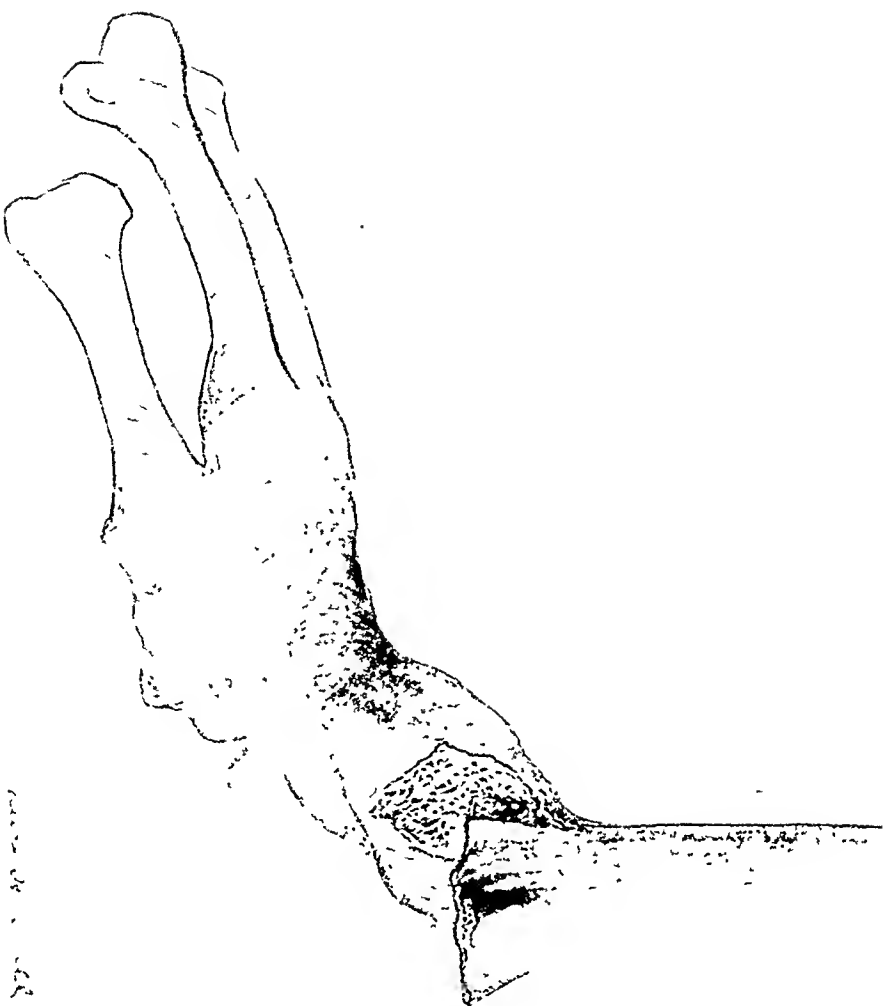


FIG. 96.—The broken lower end of the shaft of the radius is thrust forwards and the lower articular fragment in backward rotation is made to appear to have moved laterally.



FIG. 97.—Repair after fracture of the base of the radius with unreduced backward and outward displacement of the lower fragment. From a specimen found in a dissecting-room cadaver. To illustrate especially the tendency to outward displacement of the lower fragment.



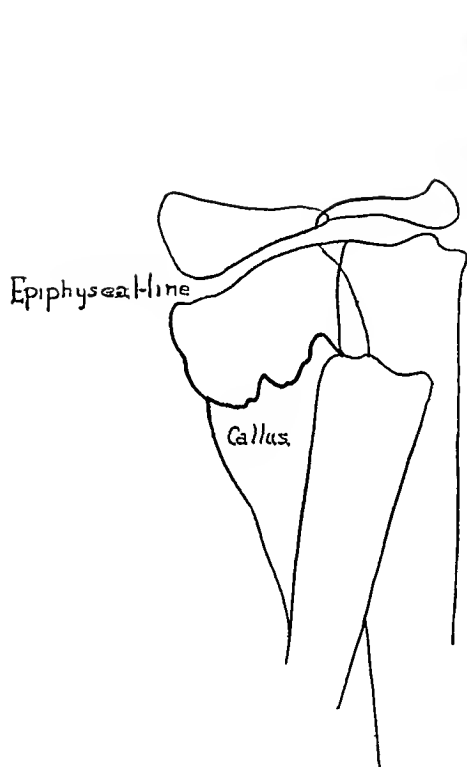


FIG. 98.—Transverse fracture three-fourths inch above articular surface in a youth. Lower fragment carried strongly outwards and backwards; no impaction; periosteum stripped up and angle filled with callus. See Fig. 85.



FIG. 97.—Fracture of the lower end of the radius and ulna with anterior displacement of the lower fragments. *a*, lower fragment of the radius; *a'*, fracture surface of lower end of shaft of radius; *b*, lower fragment of ulna. (Hitzrot, ANNALS OF SURGERY, June, 1915.)

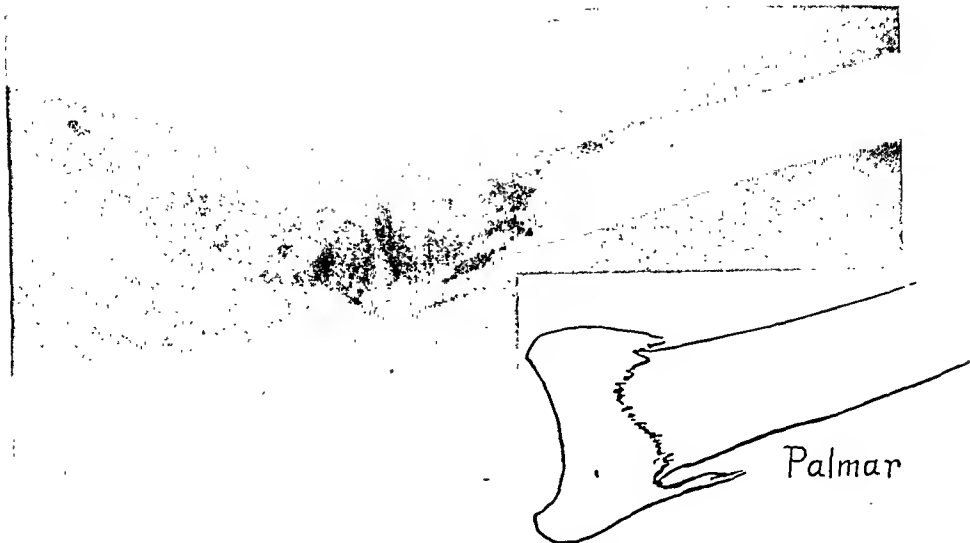


FIG. 100.—Transverse fracture with impaction of upper into lower fragment; fragment of articular segment displaced forward.



FIG. 101.—Lower fragment displaced forward, exaggerating the normal palmar projection of the anterior lip.

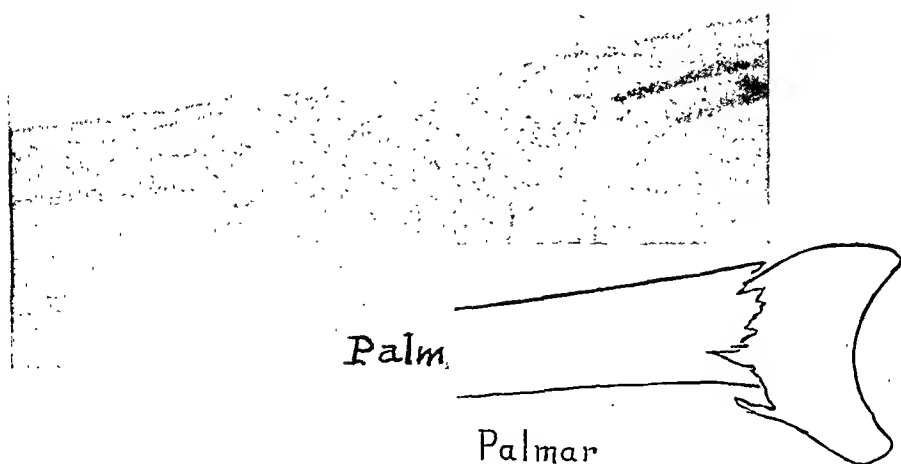


FIG. 102.—Anterior displacement of lower fragment.

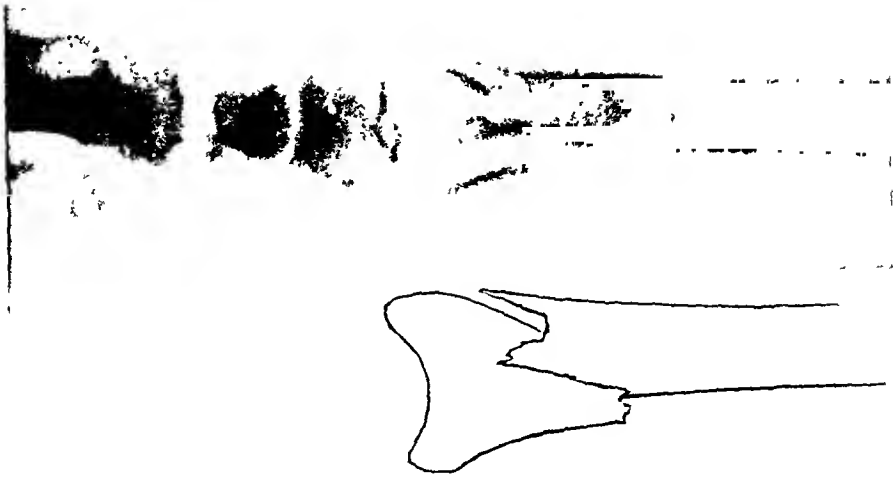


FIG. 103.—Anterior portion of lower fragment displaced *forward*. (Seibert.) See anteroposterior view, Fig. 104.



FIG. 104.—Lower fragment displaced forward; slight impaction of upper into lower fragment. Styloid process of ulna broken off.

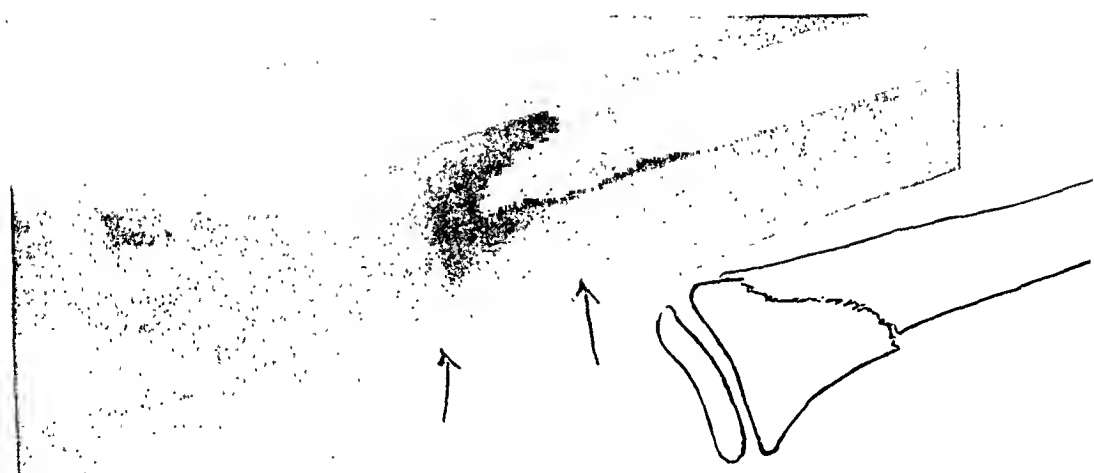


FIG. 105.—Oblique fracture in anteroposterior line of lower end of radius in a child seven years of age. One arrow points to the epiphysial line, one to the line of fracture.

## FRACTURES OF BASE OF RADIUS

In 1904, Dr. Francis T. Stewart, of Philadelphia, reported to the Academy of Surgery of that city the case of a man fifty years of age who had received a fracture of the lower end of the radius from the blow of a heavy weapon upon the back of the wrist. Skiagrams showed the lower fragment displaced to the palmar side. Dr. John B. Roberts at the same time described the case of a woman who had been thrown from a horse and struck on the back of her hand. The lower extremity of the radius was fractured and the lower fragment was driven forward (ANNALS OF SURGERY, 1904, xl, 423).

In 1915, Dr. J. M. Hitzrot, of New York, reported to the New York Surgical Society (ANNALS OF SURGERY, 1915, lxi, 740) a similar case. A woman was thrown from a horse and fell with her left hand flexed under her. Together with other injuries the lower ends of the radius and the ulna were fractured and the lower fragments were displaced forward and outward to the radial side. The lower projecting ends of the upper fragments could be plainly seen and palpated on the back of the wrist. Skiagraph (Fig. 99) shows the lower fragments of both radius and ulna completely displaced forward and driven upward along the palmar surface of the radius. Traction and manipulation failed to correct the position, whereupon the parts were exposed by an incision on the dorsum, when it was found that the lower end of the upper radial fragment had perforated the annular ligament by the fibres of which it was held and the whole mass of the extensor tendons had dropped between the fragments. After operative readjustment of these structures had been effected, the proper apposition of the bone ends was readily made and a final ideal repair secured.

Among the cases which are the subject of the present study a number have already been figured (Figs. 61-64) in which anterior displacement of some of the comminuted pieces of the fragment, riven by the descent into it of the end of the upper fragment, is present.

In Figs. 101 to 105 are presented other examples in which the articular segment is displaced forward. In the case which is the subject of Fig. 47 the anterior lip of the carpal articular surface has been split off by a longitudinal line of fission which exaggerates the normal palmar projection of that part of the radius. These cases, however, together with the similar ones already noted on page 8, belong to quite a different class from those with anterior displacement considered by Smith and Roberts, and from the case of Hitzrot shown in Fig. 99. In the latter class we have to do with a distinct forward movement *en masse* of the fragment.

When one considers the histories of the cases in which such anterior displacement of the lower fragment has been found it is evident that they are the results of direct violence applied to the dorsum of the lower end of the radius rather than of any such indirect force as that which plays so large a part in the causation of the ordinary fracture occurring during extension of the wrist.

In Figs. 103 to 105 the condition of the lower end of the radius speaks plainly for a blow directly upon the dorsum of the articular expansion of the bone, breaking it off and driving it forward. This particular condition shown in Figs. 103 and 104 occurred in the person of a heavy woman, thirty years of age, who fell in alighting from a trolley car. Presumably she put out her hands to break her fall. No positive statement as to the exact manner in which the wrist came in contact with the pavement can be given by her.

The displacement shown in Fig. 105 is quite similar to that in Fig. 103. The obliquity of the line of fracture running upward and forward and the slight forward slide of the lower fragment speak positively for it to have been caused by a force from the dorsum. It occurred in the person of a child, seven years of age, who tripped while running over a boardwalk and fell violently forward.

*Epiphysial Separations.*—In children and adolescents, up to the age when the conjugate epiphysial cartilage becomes ossified—nineteenth to twentieth year—the result of a cross-breaking strain upon the lower end of the radius may be that the fragment that is torn off is composed practically of the epiphysis only (Figs. 85, 86, 106, 107, 108, 109). Owing to the relatively small size of the bony nucleus of the epiphysis during early childhood the base of the radius during this period partakes of the tough and elastic characteristics of the predominating cartilage rather than of the friability and density of bone. After the age of twelve the osseous development of the epiphysis has advanced so far as to materially alter its physical nature. The cases of epiphysial separation recorded are practically limited to the years between twelve and twenty. The separation, however, seldom, if ever, occurs through the substance of the cartilage but rather through the spongy, osseous tissue which immediately adjoins it (Ollier), a certain amount of which always clings to the cartilage. Not infrequently the fracture plane, which has begun along the epiphysial line in front, passes into the substance of the diaphysis as the posterior surface of the radius is approached by the fracture line (Fig. 109). Epiphysial separations are comparatively infrequent because the elasticity and resiliency of the osseo-cartilaginous tissues of childhood lessen the tendency to any fracture at the wrist, notwithstanding the frequent falls that are characteristic of the heedless activity of childhood. A child's fall, broken by the outstretched hand, more frequently eventuates in a fracture of the forearm or in a dislocation at the elbow than in a fracture through the lower end of the radius. The bone may give way through the shaft at a point but little above the epiphysial line, without any

## FRACTURES OF BASE OF RADIUS

involvement of the epiphysial conjugate cartilage. Such a condition is presented in Figs. 87, 88, 98, 105.

*Arrest of growth* of the radius from premature ossification of the lower epiphysial conjugate cartilage, the result of the traumatism of a fracture, may result, but is rare. Of 100 cases of traumatic epiphysial separation of various bones, collected by von Bruns, in 13 only was growth arrested; eight of these were of the lower epiphysis of the radius. Fig. 110 shows the condition produced by lack of development in length at the base of the radius after a fracture through the epiphysis sustained at the age of twelve years. The normal growth of the ulna has made its lower end to become very prominent on the ulnar side of the wrist, while the carpus, bound more strongly and extensively to the radius, is left behind and pushed over to the radial side of the wrist. There is no suggestion of shortening of the radius from unreduced overlapping of the fragments of the original injury. This wrist was seen by the writer immediately after the original accident; the backward displacement of the lower fragment was very marked; it was reduced without difficulty, and the subsequent course of repair was without accident. Twenty years later, the boy having become a man thirty-two years old, an opportunity occurred to examine the wrist, and the condition as shown in the figure was found present. A plaster cast was taken of it, from which the photograph reproduced in Fig. 110 was taken. The function of the wrist has not been impaired.

Poland ("Traumatic Separation of the Epiphyses," p. 564) says that there are several specimens in the museums of London hospitals which show great dwarfing of the radius and deformity of the forearm after what was probably an epiphysial separation. He reports also a number of clinical cases in which arrest of growth of the radius followed such epiphysial separation. Great or complete displacement of the epiphysis, as in the case of my own patient, must usually have taken place to supply the conditions requisite for arrest of growth at the base of the radius, which is due to the premature ossification of the conjugate cartilage during the process of repair. Such premature excess of ossification occurs more especially in comminuted fractures which involve the extremity of the diaphysis as well as the epiphysis. But in some of the recorded cases of arrest of growth after epiphysial injuries there has been no displacement and in some but little local injury.

Authors in treating of wrist injuries in childhood, and surgeons in undertaking the treatment of such cases, ought to be very explicit to state the possibilities of later deformities appearing as the result of develop-



mental changes, over which the surgeon has no control, and for which he may in no degree be responsible or deserving of reproach.

*Dorsal Untorn Periosteum.*—The peculiar elements which determine the usual fracture of the radius *par arrachement* are such that as the lower fragment is torn away from the rest of the bone and slips backwards, it tends to strip up from the adjacent dorsal surface of the shaft of the radius more or less of the dense, loosely adherent periosteum which enwraps this part of the bone. The dorsal periosteum further is so closely blended with the fibrous tissue of the tendon sheaths which lie over it that the combined mass constitutes a thick strong fibrous envelope to the parts enclosed within it. This has been repeatedly referred to in previous paragraphs and is well shown in many of the figures already presented to illustrate other phases of this injury—see especially Figs. 31, 32, 33, 69, 72, 73, 89, 93, 96.

This untorn portion of the dorsal periosteum becomes a sort of ligament which continues to connect the two fragments, and exercises some control over their relations to each other, and also remains as a determining factor in the extent and position of the callus which is formed to weld them together again.

As soon as the extending force is withdrawn and the hand again falls into forward flexion, this pseudo-ligament is made tense (see Fig. 33) and in its tension binds in its faulty position the lower fragment in whatever degree of entanglement with or impalement upon the lower end of the upper fragment it may have sustained. This effect is well shown in Figs. 69 and 89. This band forms a real obstacle of some importance to the disentanglement of the fragments or to the breaking up of any impaction if it exists. To break up such impaction or to disentangle an overriding fragment is necessarily the first step to be taken in any effort of reduction. The appreciation of the presence and effect of this band gives an important hint as to the first manipulative step to resort to when reduction is undertaken. To facilitate the drawing apart of the broken surfaces this band must be relaxed. Such desired relaxation is at once secured by putting the hand again in full dorsal flexion (Fig. 31).

As long as the return of the lower fragment to its normal relation with the upper fragment is imperfect a space is left between the stripped up periosteum and the compact layer of the denuded bone. This space fills with blood clot to be later replaced by callus which solidifies duly into bone. The amount of this new formed bone and its contour is quite accurately outlined by the periosteum that contains it. This formation of new bone underneath the periosteal bridge did not escape the notice



FIG. 106.—Separation of epiphysis with backward displacement. Lateral view (Fig. 86) shows moderate backward displacement of the radial epiphysis making an angle with the dorsum of the lower end of the upper fragment which is filled with callus.



FIG. 108.—Lateral view shows the epiphysis torn off and displaced backwards for half the thickness of the bone.

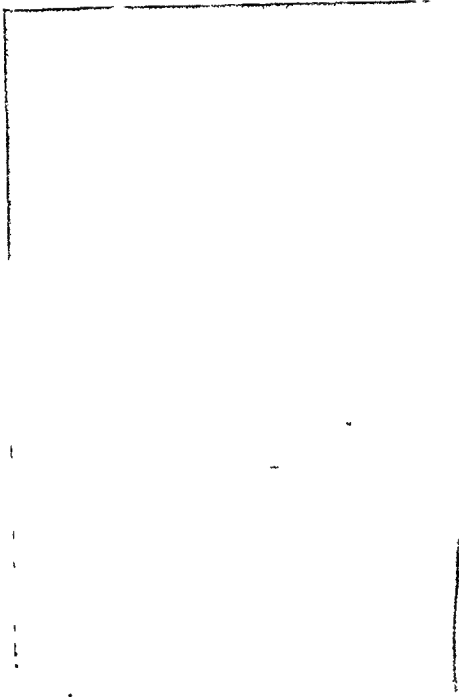


FIG. 107.—A lateral view of this case shows slight backward displacement of the epiphysis with line of fracture extending near posterior surface upwards into the substance of the diaphysis.



FIG. 109.—Epiphyseal separation with backward displacement of the epiphysis—child of thirteen years. Dorsal angle filled with abundant callus. See Fig. 85

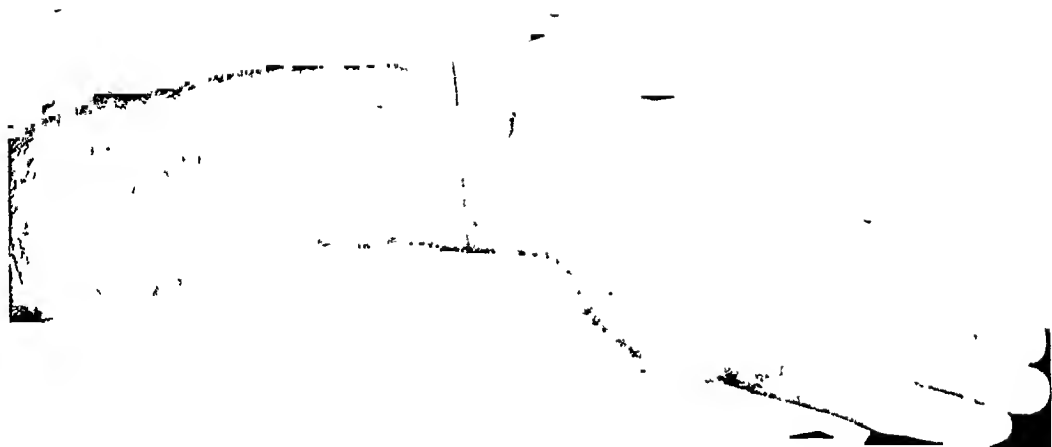


FIG. 110.—Deformity from obliteration of lower epiphysial cartilage of radius, following fracture of the base of the radius in a boy of twelve years; fragments put in good place and healed without deformity at the time. Gradual development of the condition shown in photograph with the growth to manhood of the boy; cast taken at age of thirty-two. Radius relatively short from lack of development in length; ulna prominent; hand inclined to radial side.

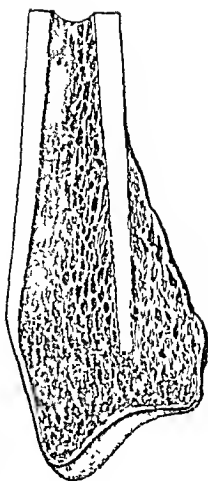


FIG. 111.

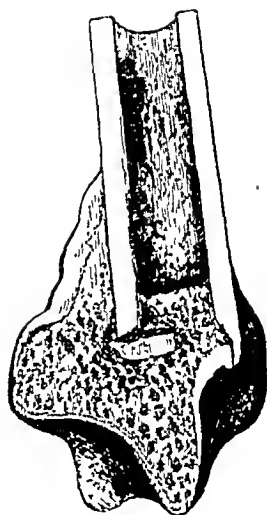


FIG. 112.

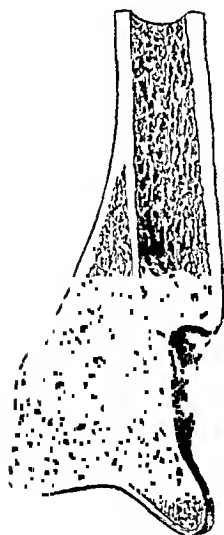


FIG. 113.—Sagittal section of old fractures of the lower extremity of the radius, healed in deformity, to show the results of the stripping up of the periosteum from the dorsum of the shaft; the subperiosteal space produced has been filled with callus which by its ossification mimics penetration of the cancellous lower end of the bone by the compact tissue of the shaft above. From Robert William Smith's *Treatise on Fractures in the Vicinity of Joints*, 1850, pp. 148, 149, 152 and 154.

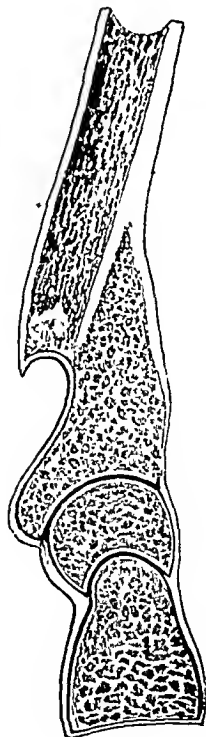


FIG. 114.

## FRACTURES OF BASE OF RADIUS

of earlier writers on this fracture, although misinterpreted by some as an evidence of impaction. Figs. 111 to 114 are the familiar illustrations from Robert William Smith's "Treatise on Fractures in the Vicinity of Joints," Dublin, 1847. They show sagittal sections of old fractures of the lower extremity of the radius healed in deformity. It is to be noted that the defect left on the palmar side by the backward slipping of the lower fragment, where the periosteum was torn cleanly across, has not been filled up, but the end of the upper fragment continues to project sharply,—see especially Figs. 113 and 114. Posteriorly, however, where the periosteum has been stripped up as described, abundant new bone has been laid down, reaching some distance upwards along the dorsum of the radius and enclosing deeply the cancellated cylinder that is here present. Figs. 97 and 98 show the result of the same source of new bone formation.

*Incomplete Fractures.*—That the lower end of the radius is frequently torn off but partially on account of the feebleness of the avulsive force, or because of there being in the particular bone an unusual degree of strength to resist such force is to be expected if we are correct in the description of the mechanism whereby the more serious injuries are produced.

The longitudinal splits and the radiating fissures of the articular facet of the base of the radius (Figs. 35, 42, 47, 48, 49), are included in this class, and also those many cases in which the lower fragment is torn off, but not displaced backward, being still held by the periosteal hinge on the dorsum (Figs. 115, 116, 117). This is ideally shown in the experimental fracture shown in Fig. 9. It is the condition in the specimens from which skiagraphs 11, 12, 28, 30, and 73 have been taken. When the force of extension is suspended in such cases the fragments spontaneously resume their proper relations to each other and no deformity follows. Under rest repair rapidly takes place. The injury is classed simply as a sprained wrist unless a skiagram is taken and the real lesion demonstrated.

*Fracture of the Ulnar Styloid Process.*—Reference to many of the preceding illustrations (Figs. 12, 24, 27, 47, 48, 52, 53, 55, 60, 70, 95, 99, 104), which present skiagrams of recent fractures, shows in each that the styloid process of the ulna has been torn off, in addition to the injury to the radius. This injury to the ulna is a very frequent one, and is almost inevitable when there has been much backward displacement and rotation outwards of the articular fragment of the radius. The mechanism of its production has been described on page 9. The carpo-ulnar fibres, of the anterior common ligament (Fig. 2b), sustain

most of the cross-breaking strain after the articular base of the radius has given way, and the tendency is to tear off the styloid process into which these fibres are inserted, a result which in fact frequently follows. In extreme degrees of violence the jagged end of the broken ulna may be forced through the skin. The student of the literature of fractures will remember the laconic but comprehensive account given by Sir Astley Cooper, in his "Treatise on Dislocations and Fractures of the Joints" (7th ed., p. 378), of such a case, under date of June 21, 1818: "John Winter fell from a ladder on his hand and knee; the hand was bent back, and the ulna protruded at the inner part of the wrist. Mr. Steel, of Berkhamstead, attended; the bone was reduced, a roller was put around the wrist, and the wound healed very soon by adhesion."

*Associated Fracture of the Carpal Bones.*—That the carpal bones are not frequently fractured or dislocated as the result of violence sustained by the wrist is due not only to the protection which they receive from the dense and strong fibrous ligamentous and tendinous structures by which they are invested (see Figs. 1, 2, 4), aided by the tonicity of the muscular masses by which these tendons are controlled, but also by the powerful manner in which the most frequent forces of extreme flexion backwards or forwards are transmitted upwards to the base of the radius. In this connection those injuries are not considered which are caused by direct force, as a blow or a crush. As, however, one values the strength of the disruptive force which the scaphoid and semilunar bones especially must sustain in the course of such a traumatism as is present in a forced hyperextension one is sure that in occasional instances these bones of the carpus will be fractured or forced out of their position at the same time that the radius is fractured, and that in some instances the chief lesion will be sustained by them,—the greater the force and the more resistant the lower end of the radius the more positive the effect upon the adjacent bones of the carpus. Thirty-five years ago I had the opportunity of dissecting the wrist shown in Fig. 24 which had been injured by a fall from a height of 20 feet to the ground. The sketch was made at the time the dissection was done. In this wrist I found that not only had the styloid processes of the radius and of the ulna been torn away but that the semilunar bone had been fractured transversely as shown in the drawing. Similar injuries both of the semilunar and of the scaphoid were occasionally detected by me in the course of many experiments made on the cadaver as to the results of overextension of the wrist when associated with force applied from above and transmitted through the bones of the forearm to the wrist. In 1905 Codman and Amory (*ANNALS OF SURGERY*, xli, 321)

FIG. 115.



FIG. 116.

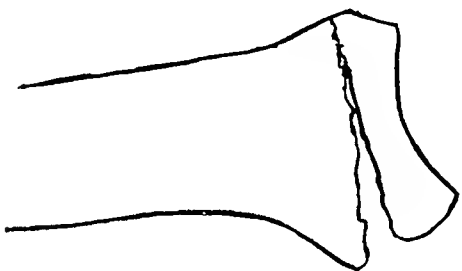
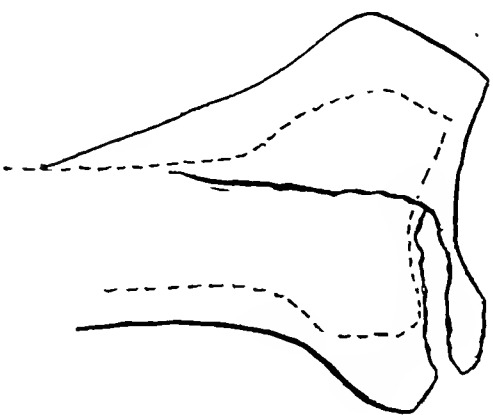


FIG. 117.



FIGS. 115, 116 and 117.—Incomplete fracture of the base of the radius. Diagrams constructed from skiagraphs.



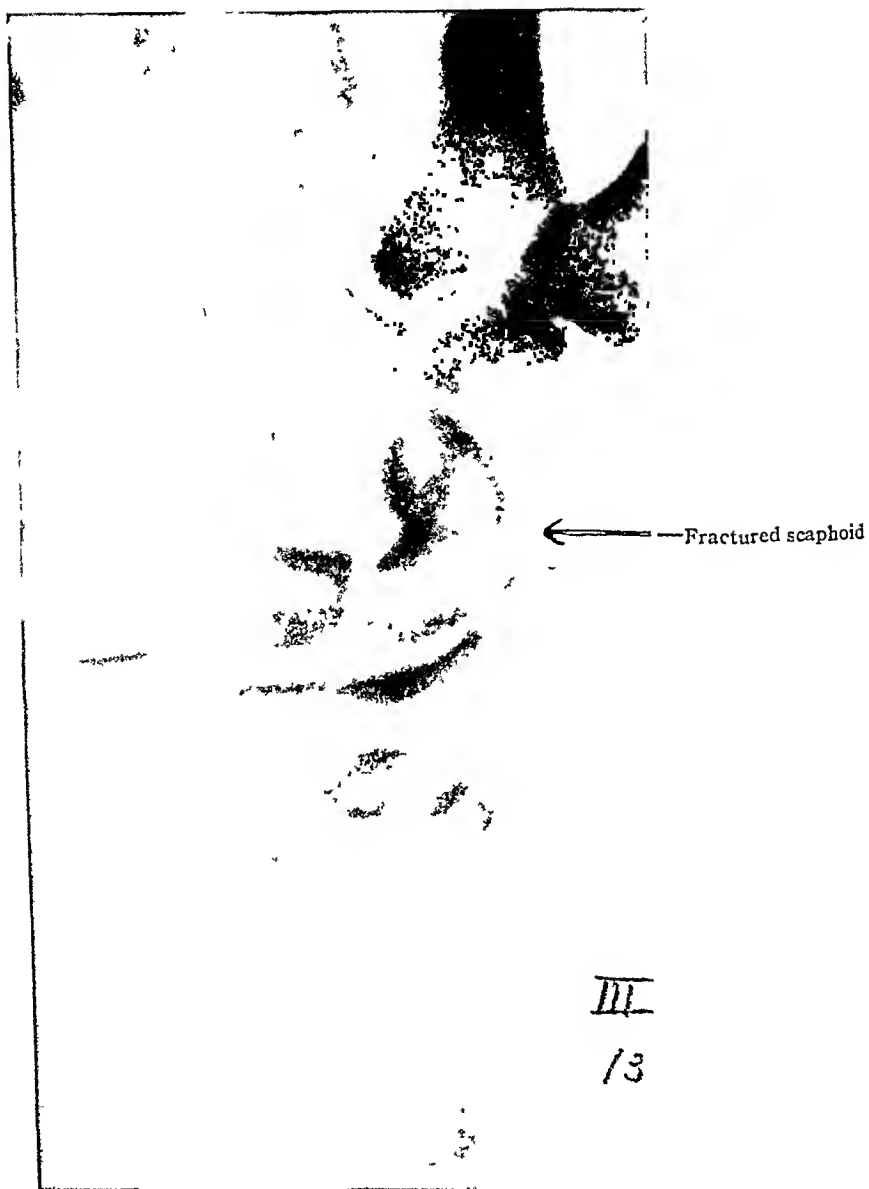


FIG 118.—Fracture of the scaphoid bone, associated with transverse fracture of the base of the radius and fracture of the styloid process of the ulna

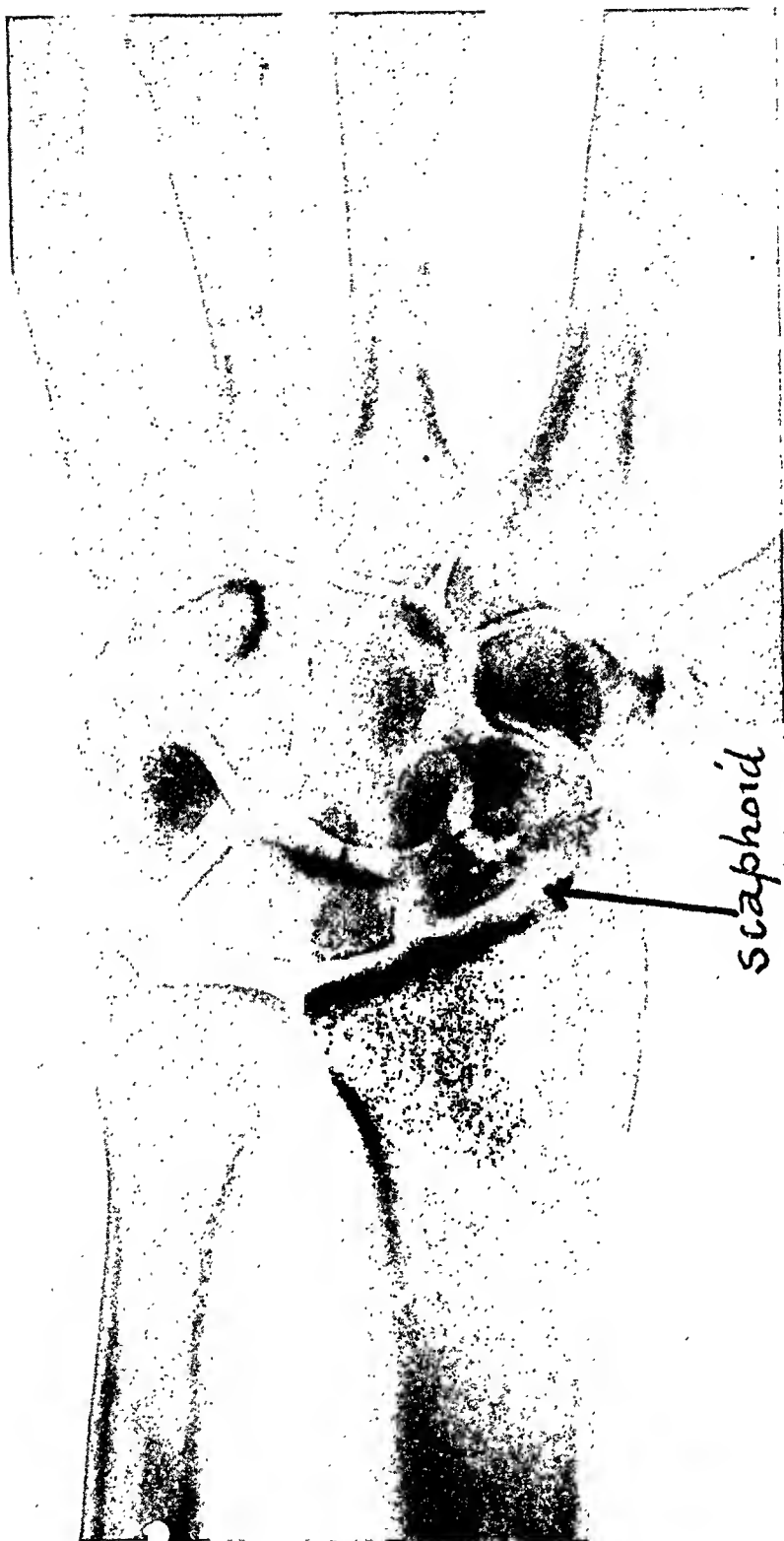


FIG. 119.—Fracture of the scaphoid bone; produced by an automobile crank "kickback."

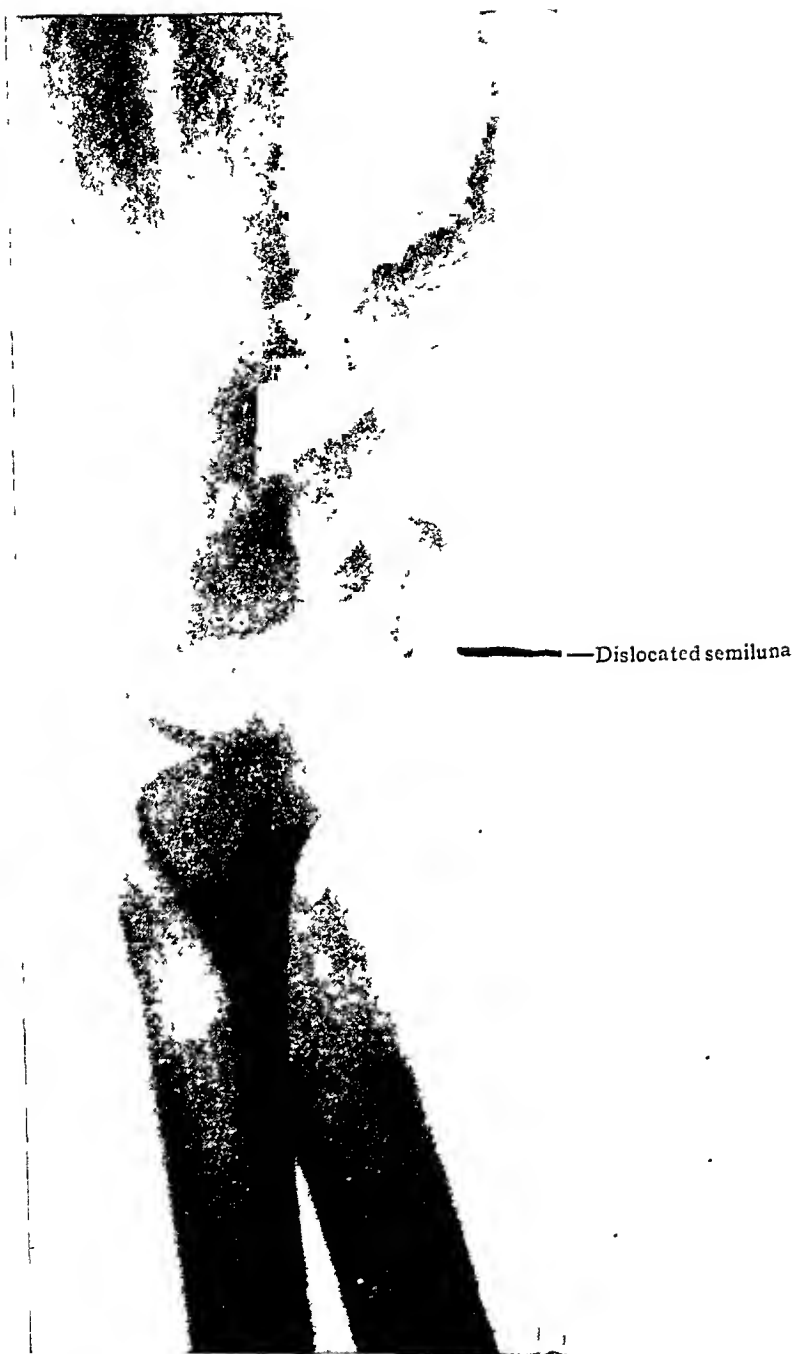


FIG. 120.—Dislocation forward of the semilunar bone, produced by an automobile crank "kickback."

## FRACTURES OF BASE OF RADIUS

published their elaborate study on "Fracture of the Carpal Scaphoid and Dislocation of the Semilunar Bone." A large proportion of the cases reported by them were the result of the same kind of traumatism as that which is the usual cause of fractures of the base of the radius, and some of them were associated with recognized fractures of the radius. Among our own cases, in the one from which the skiagraph, shown in Fig. 118, was made a fracture of the scaphoid can be clearly discerned. The fractured scaphoid shown in Fig. 119 and the dislocated semilunar shown in Fig. 120 were both produced by the hyperextension of a wrist caused by a kick back of an automobile crank and singularly enough in the same individual at different times; the scaphoid of the right carpus having been first broken and, three months later, as the result of the same kind of force, the left hand being now used, the semilunar bone of the left carpus was squeezed out of its place as shown in the figure. The radius escaped injury in both instances. Continued tenderness and prolonged disability in a wrist following a fracture of the base of the radius, after repair of the bone has taken place, should awaken suspicion as to the presence of coincident injury to the carpus, and call for careful examination as to its presence.

*Associated Injuries to the Periarticular Structures and Diastasis of the Ulna.*—When the lower fragment of the radius comprises the whole width of the bone and is carried backward to any degree (Fig. 96) the ligaments that bind it to the head of the ulna now sustain the greater part of the residual strain; and, as a result, first, the hand, carpus and lower fragment rotate in a backward direction around it, as already described on page 9, the contour of the wrist is altered; the radial fragment, thrown into supination, projects on the outer side of the dorsum and the head of the ulna appears more prominent on the inner anterior aspect of the wrist (see Figs. 65 and 67). If the force has become expended at this point, the radio-ulnar ligaments still hold, and no diastasis of the head of the ulna from the radius occurs. In the skiagraphs which have already been presented examination shows no separation of the head of the ulna in a large proportion of them (see Figs. 10, 11, 13, 14, 16, 50, 51, 57, 58, 59, 98, 106, 107, 108). Not infrequently, however, especially when the fall has been from a height or with much violence, the radio-ulnar ligaments are ruptured and the head of the ulna, torn from its radial connections, is driven inwards, forwards and downwards in varying degrees according to the degree of violence inflicted. In some instances, as illustrated in Figs. 52 and 54, the ulna, after being torn loose, is merely forced away from the radius, broadening the wrist and projecting on the ulnar side. Figure

118 shows a greater degree of displacement downwards of the head of the ulna. Compare also Figures 12, 15, 53, 55, 104, 109. Still greater degrees of displacement, some of them very extreme, are presented in Figures 56, 59, 60, 70, 91, 92, 93, 94 and 95. It is in this last class of cases that occasionally the ulna is thrust through the skin. The external deformity produced in these cases of extreme displacement is very marked (see Fig. 121).

It is a misnomer to speak of these conditions as dislocations of the ulna. It is not the ulna that is dislocated or torn away from its attachments to the radius; it is the torn off fragment of the radius, carrying with it the carpus and the hand, that is dislocated and separated in varying degrees from its relations to the ulna. The injuries that are sustained by all the soft tissues about the wrist joint, coincident with the bone lesions that have been described, are extensive and important. Ligaments are violently stretched and partially lacerated even in the minor degrees of injury; sometimes they are entirely ruptured; the synovial sacs of the articulations are badly contused and sometimes lacerated and filled with blood; the sheaths of the tendons, both in front and behind, are injured; in front the projection of the ragged edge of the upper fragment into the midst of the flexor tendons may lacerate their sheaths and irritate the tendons, while behind the stripping of the periosteum and its later continued tension involves in its results the extensor tendon-sheaths with the floor of which it is intimately blended.

Effusions of blood and lymph into the anterior tendon-sheaths and adjacent connective tissue spaces quickly produce a well marked swelling on the front of the wrist above the annular ligament which exaggerates the deformity formed by the bone displacement and may simulate displacement when it has been rectified. On the back of the carpus some swelling of similar character also forms, as a rule. These effusions are firm, are slowly absorbed, especially in the feeble and aged and tend to provoke adhesions along the course of the tendons which they envelop.

*Permanent Alteration in Contour of the Base of the Radius.*—In a considerable proportion of the cases of fracture of the base of the radius in which appreciable displacement of the lower fragment has taken place some actual permanent alteration in the form of the fragment has been produced so that perfect restitution of the normal contour of the part is impossible by any treatment and some permanent deformity is unavoidable. Some of the cancelli of the lower fragment are crushed and condensed, and in some cases more or less absorption



FIG. 121.—Prominence of ulna and shortening of radius, after fracture of lower extremity of radius with marked backward displacement of lower fragment (see Figs. 60 and 95).



## FRACTURES OF BASE OF RADIUS

of osseous tissue later takes place, so the bone is permanently shortened and the form of its lower extremity is changed. Such changes in the bone contour are the unavoidable result of the accident itself; they cannot be prevented by treatment, nor can their presence reflect in any unfavorable manner on the treatment given. The possibility of arrest of growth of the radius following epiphysial displacements has already been discussed (page 13). In its least degree this change in the form of the base of the radius is well shown in the radius depicted in Fig. 75. See also Figs. 100, 101, and 102. A higher degree of damage is seen in Figs. 50 to 55, 57, 58 and 60. The most marked change is in those fractures in which the lower fragment is virtually telescoped by the lower end of the upper fragment and its comminuted fragments driven explosively in various directions. See Figs. 61, 62, 63, 64. In the more extreme cases in which the lower fragment is carried at once so far backwards as to clear the upper fragment and ride upon its dorsum (see Figs. 56, 71, 88, 89, 90, 91, 92, 94, 98, 113, 114) such injury to the bony structure of the lower fragment is escaped, and if the lower fragment is completely replaced a fair restitution of the normal contour of the bone is obtained. It is by the failure to fully disentangle this lower fragment and bring it down fully into its proper place that the most marked deformities are perpetuated. If the backward displacement is allowed to remain in any degree, the vacant subperiosteal angle (Figs. 31, 33, 69, 70, 85, 86, 89, 93, 95, 96, 97, 98 and 111-114) left will in time be filled in with new bone, which will enclose the compact lamina of the lower end of the upper fragment to the point where its periosteum had been stripped from it. Any shortening of the radius will make prominent the head of the ulna as the carpus and hand fall to the radial side. In point of actual observation the projection of the end of the ulna on the inner anterior aspect of the wrist is the most noticeable and frequent permanent sequel of this fracture. This projection of the ulna is shown in varying degrees in Figures 67, 121 and 110. The alteration in the plane of the carpal articular facet of the radius, so often remaining, has been already fully discussed in another connection. A further word should be said as to the cause and significance of the persistent protrusion of the head of the ulna. It has already been stated that when the radius has given way the tendency is for the whole hand and the carpus to be carried backward and outward, as in supination, with the broken off fragment of the radius, as it rotates around the head of the ulna. As a result of this movement the back of the radius becomes approximated to the styloid process of the ulna and the head of the ulna is made to project notably upon the



front and inside of the wrist where it is firmly held as long as any backward displacement of the lower radial fragment remains unreduced, or the radius is shortened in its vertical length.

The exact cause of this movement and this locking I have made a subject of frequent experiment. It occurs in experiments on the dead body equally as well marked as in the living body; it is, therefore, not the result of muscular action. Removing integument, annular ligament and superjacent tendons, no change results; entanglement of the styloid process in the annular ligament, therefore, is not necessary for its production. If the greater part of the anterior carpo-ulnar fibres are cut away, no relaxation results. If the triangular fibrocartilage be now exposed, though this be without tension and thoroughly relaxed, the ulna and wrist are still firmly bound in their new relations to each other.

The real cause of these phenomena is now revealed to be the strong fasciculus of the common anterior ligament of the wrist which passes obliquely upwards to the ulnar side to be inserted into the anterior border of the styloid process of the ulna. This fasciculus has already been mentioned as the medium through which this styloid process is so frequently broken off. The obliquity of its direction and the extent and place of its insertion govern the movements which the movable parts attached to it may make. As long as the carpus and the attached fragment of the radius are in backward displacement, this fasciculus is kept tense and all rotation is prevented.

Prominence of the head of the ulna with widening of the wrist and loss of the anterior projection of the articular lip of the radius and the imposition of a more or less backward inclination upon the plane of the carpal articular surface of the radius are therefore the most common permanent alterations in the anatomical configuration of the wrist as the result of a fracture of the base of the radius. The result of these anatomical changes is to perpetuate in some degree in many cases the deformity which immediately followed the accident. The inward and forward projection of the lower end of the ulna may persist even when there is no appreciable deformity of the radius, through lack of full restoration of the close ligamentous bands that before the injury tied it to the radius.

The bony deformity, even when marked, as a rule entails of itself but slight if any functional disability; the chief sources of disability following this injury are the consequence of the periarticular changes, such as the matting of tendons and the contracture of the ligaments and the formation of fibrous bands and adhesions due to the laceration and irritations of these structures consequent upon the bony injury

and displacement. Too prolonged immobilization and the undue pressure of retention splints too forcibly secured may aggravate the amount of disability referable to the injury itself.

*The diagnosis* in many cases is self declared the moment the wrist is seen, so characteristic and plainly marked is the deformity (Figs. 65-68). The other cardinal signs of fracture, crepitus and abnormal mobility are often obscured, even prevented, by the amount of displacement and impaction and the resistance of untorn fibrous connecting bands, all of which conditions have been considered in preceding pages.

In cases in which the degree of displacement, and consequently the extent of deformity, is but slight, careful palpation will usually enable the surgeon to recognize the loss of the projection formed by the anterior lip of the sound bone and some abnormal elevation of the lower fragment on the back of the wrist. In the absence of any appreciable displacement the lesion of the bone may still be inferred if pressure elicits a point of special tenderness on the outside of the radius near the base of the styloid process, since such tenderness at that point could not result from any ligamentous rupture. Forward displacement of the head of the ulna is recognized at once on inspection of the wrist and when present indicates the coexistence of fracture of the radius; fracture of the styloid process is indicated by special tenderness at its base; manipulation may elicit undue mobility and crepitus, but it is rarely so completely torn away as to become notably displaced.

Fracture without great displacement is often overlooked, and being regarded as a simple sprain is permitted to heal without effort to prevent deformity. In every case of injury to the wrist following violent backward flexion, accompanied with ecchymosis, local swelling and impairment of function, the presence of fracture is to be inferred, even though one fails to elicit any of the signs of it that have been mentioned.

The final authority as to the character and extent of the injury is the X-ray, and resort to it should be made whenever practicable both to confirm and correct the diagnosis and later to demonstrate the degree to which proper reposition of the fragments has been secured.

In all doubtful cases the information to be derived from the X-ray plate is most desirable and as a help to the surgeon in directing his treatment is invaluable. Both anteroposterior and transverse views should be taken.

*Treatment.*—If displacement exists its accurate reduction is of first importance. The chief obstacles to ready and perfect reduction are the impaction or entanglement of the uneven surfaces of the fragments, and the tension of the untorn periosteofibrous band which still unites

them at the back. The latter can be overcome at once by placing the hand in dorsal flexion; while the hand is still in this position extension will disengage the fragments, and firm thumb pressure upon the back of the lower fragment will push it forward into place. This method of manipulation is well shown in Fig. 122.

If the hand is then brought into palmar flexion while extension is continued and the thumb pressure on the back of the lower fragment is still maintained, the fragments come into normal relations, the fracture surfaces fall together and the normal contour of the bone is restored. Figs. 124 and 125 are from skiagraphs of a wrist of a woman who had slipped on the pavement and had received the brunt of her fall upon her extended hand. The fractures sustained are shown in Fig. 124. The amount of backward displacement was sufficient to produce a typical silver-fork deformity of the wrist, and to wrench off the styloid process of the ulna as shown in the skiagraph. I saw her within a few minutes after the accident and subjected the injured wrist to the manipulations described. The perfection of the reposition is shown in the skiagraphs (Figs. 124 and 125) which were taken the next day so as to secure an X-ray record of the case. No general anæsthetic was required in this case to facilitate the reposition. Indeed I have rarely felt any need of such anæsthesia in dealing with a recent fracture of the wrist. If the patient is an hypersensitive or apprehensive individual or a child ether or chloroform will naturally greatly assist the surgeon in his manipulations. The displacement is to be overcome *arte, non vi*. The manipulations do not require the exercise of great force nor do they inflict excessive pain.

Impaction of whatever degree is easily broken up after the tense, periosteal connecting band (see page 14) has been relaxed. If the impacting force has been great the lower fragment will be comminuted and the lower end of the upper fragment will in no sense be gripped by the pieces of the lower fragment by which it is surrounded.

If the lower fragment has been carried backward so far as to ride on the dorsum of the upper fragment—a not infrequent occurrence—all interosseous penetration is absent and the chief force that causes the displacement to persist is the tension of the stripped up dorsal periosteofibrous bands still holding the two fragments together (see Figs. 33, 69 and 89). It is not necessary to rupture these to any extent, if the manœuvres of relaxation as have been described are resorted to.

These remarks apply particularly to the most frequent forms of displacement in which a backward movement of the lower fragment is the chief and most important element. In those rarer instances in which the upper fragment has telescoped the lower fragment in such manner as



FIG. 122.—Dorsal hyperflexion with extension of disengaged lower fragment.

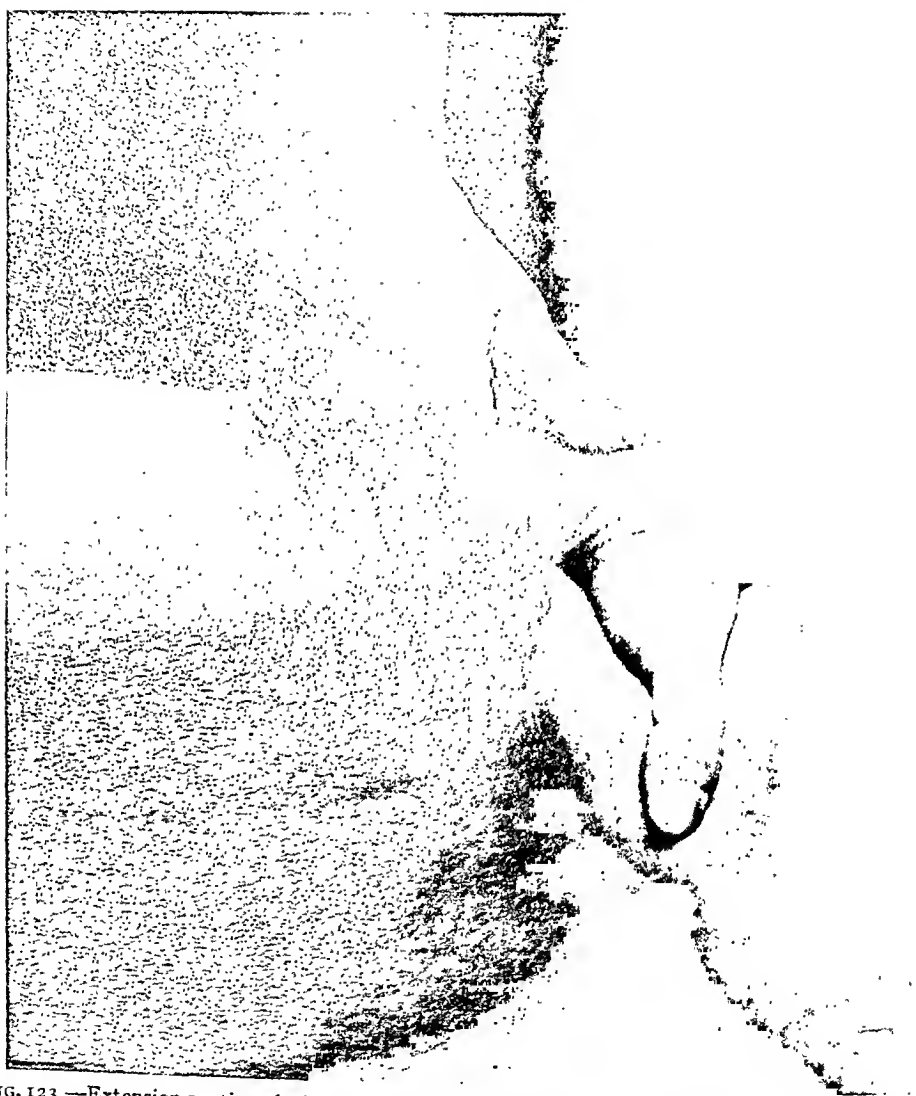
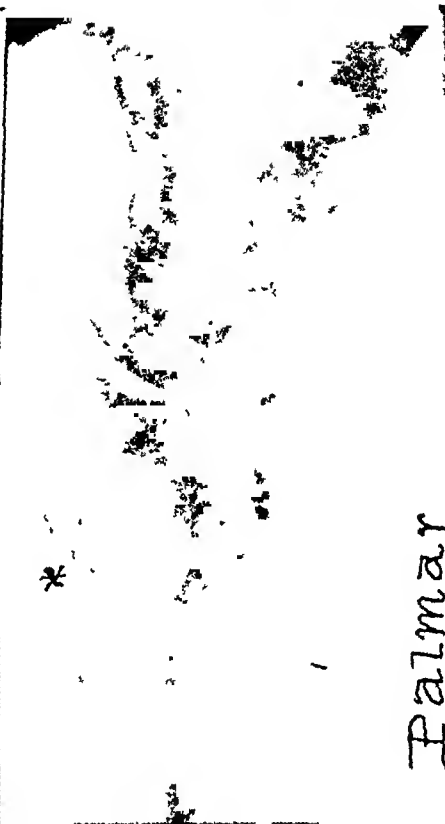


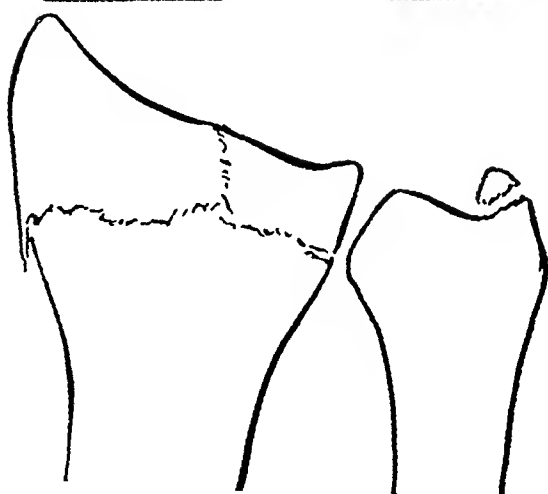
FIG. 123.—Extension continued, thumb pressure on back of lower fragments; final palmar flexion.

FIG. 124.

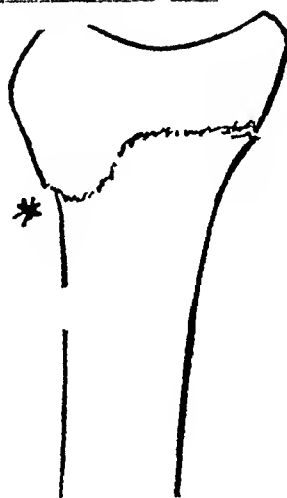
FIG. 125.



Palmar



Anteroposterior view.



Transverse view.

FIGS. 124 and 125 —Fracture of base of radius with comminution and backward displacement of lower fragment of radius with moderate impaction. Skiagraph taken after reposition to show final adjustment of the fragments secured. Note the persisting slight change in the plane of the carpal articular surface of the radius due to the mutual compression of the bony lamellæ along the posterior portion of the fragment at the point marked by the star

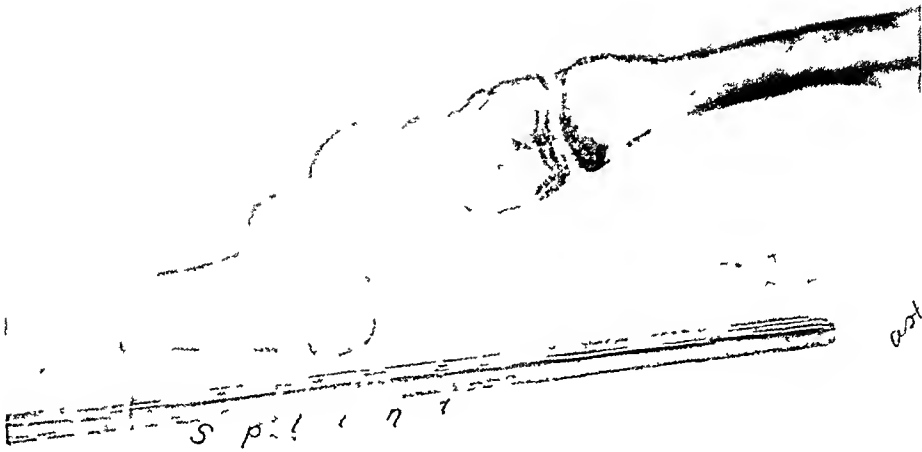


FIG 126 —Showing effect of palmar splint to maintain or reproduce backward displacement of the lower fragment after fracture of base of radius From a skiagraph taken three months after injury, original backward displacement still unreduced, fracture healed with deformity

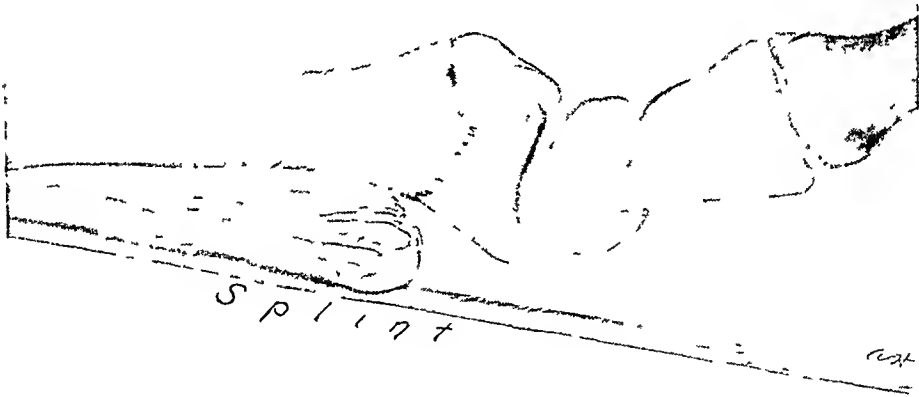


FIG 127 —Showing position and shape of special palmar pad to protect from pressure productive of backward displacement the lower fragment of a fractured radius involving the base.

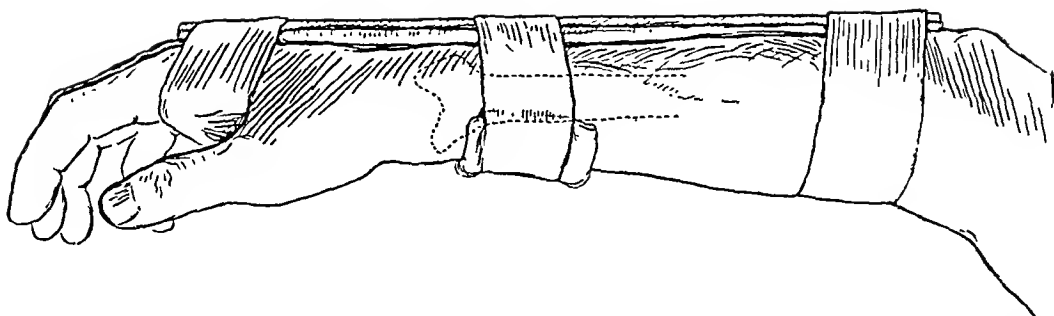


FIG. 128.—Diagram to show the adaptation of a straight splint to the dorsum of the wrist. Note the even plane of the dorsal surface of forearm, wrist and hand requiring minimum amount of padding; note the projection to the palmar side of the articular lip of the base of the radius, note the pad adjusted to the concavity of the palmar side of the base of the radius and secured so as to secure the articular lip from pressure that may displace it backwards if separated by fracture.

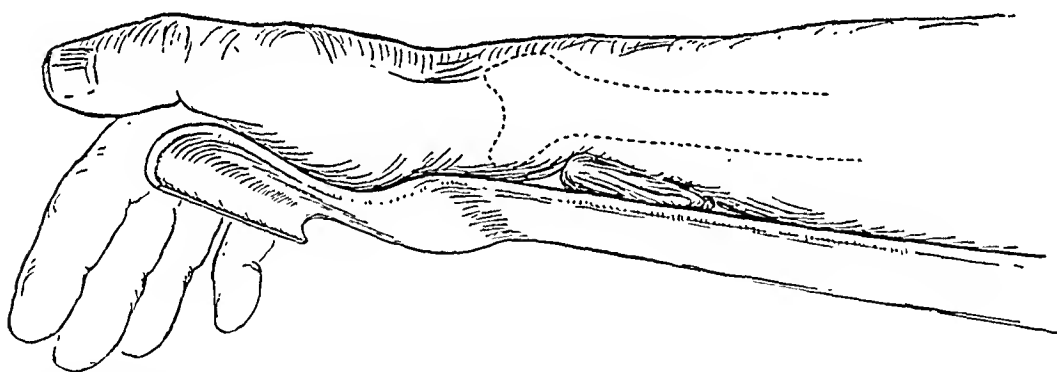


FIG. 129.—Diagram showing adaptation of the turbinated splint to the conformation of the hand, wrist and forearm. Note the use of a compress to lift the projecting lower margin of the articular expansion of the base of the radius from the pressure of the splint.





## FRACTURES OF BASE OF RADIUS

to split it and drive the pieces of the lower fragment in various directions, the best possible reposition of the fragments is to be secured by simple direct extension with approximation of the disrupted pieces by thumb and finger pressure as in a moulding process.

Some permanent shortening of the radius from condensation of the tissue of the lower fragment is unavoidable in all cases in which the upper fragment is impacted in any degree into the lower one. Such shortening will make the end of the ulna more prominent on the inner side of the wrist; the greater the shortening of the radius the more prominent the ulna (see Fig. 121). Second only in frequency to the alteration in the plane of the carpal articular surface of the radius (see page 8 and Figs. 76, 79 and 80), is this slipping away of the head of the ulna from its proper relation to the radius. The normal projection of the ulna on the dorsum of the back of the wrist disappears and an abnormal projection of it on the front and inside of the wrist persists permanently. The less the impaction and the more perfect the replacement of the lower fragment of the radius in its normal relation to the shaft of the bone the less the tendency of the ulna to show this deformity. In the further care of such a fracture attention will be required to secure and maintain full approximation of the ulnar head to its normal relation in the lateral articular facet of the radius until normal ligamentous bands have been reformed.

Ordinarily there is but little tendency to renewed displacement after reposition provided the part is protected from further direct force. Regard must always be given to the fact that any pressure brought to bear upon the palmar or anterior surface of the carpo-radial region will bear upon the projecting anterior lip of the lower fragment and may crowd that fragment back to the plane of the shaft of the bone (see Fig. 126) even though full restoration of the normal contour of the base of the radius had been secured by the surgeon before the retentive dressing was applied. Anteroposterior pressure also tends to crowd the soft tissues in between the radius and ulna, and, forcing the ulna away, to renew and perpetuate its diastasis. The first indication in the planning of a retentive dressing therefore is the adaptation to the front of the forearm of a graduated pad of proper thickness so placed that it shall shield the anterior lip of the lower fragment from pressure (Figs. 127, 128 and 129). The lower margin of this compress should fall about one-half inch above the carpo-radial articulation. It should be about three-eighths of an inch thick at this lower edge, and should extend upwards from two and one-half to three inches. It should be wide enough to wrap part way around the ulna so as to give support to that

bone also when the later circular roller is applied. A folded gauze compress answers fully for such a pad.

In the further care of the injured part the indications are to give support and immobilization, with equable compression to limit effusion, and to maintain approximation of divided tissues while repair goes on. With the subsidence of the primary wound reaction precautions to maintain the mobility of the wrist and finger joints require attention. In very many cases, in addition to the graduated compress already mentioned, a flannel roller bandage and a sling will be all the apparatus required. The slightly elastic flannel roller binds the strained and shattered parts of the wrist together and gives an agreeable sense of security and support. At this first dressing allowance must be made for the primary traumatic swelling that follows the injury, and the bandage must later be loosened or cut, whenever its constriction becomes a source of discomfort; as the swelling subsides it should be tightened again.

This circumferential compression is especially important to maintain the lower fragment and the carpus in their proper position to the ulna. It is further reinforced during the after-treatment by keeping the forearm supported on its ulnar side in a narrow sling, not extending forward beyond the distal end of the ulna, in which position the weight of the unsupported hand and wrist is an additional force tending to press the ulna into position.

The feasibility of satisfactorily treating fractures of the base of the radius by so simple an apparatus as a flannel roller and a compress I learned very early in my experience in dealing with such fractures from the teaching of the late Dr. E. M. Moore, of Rochester, N. Y., who was led to it by his views as to the importance of supporting the ulna in the course of the treatment of such injuries.

In my earlier writings on this subject I emphasized the value of the method, advocating at that time an adhesive plaster strip encircling the wrist as the chief element of the apparatus required. In part this was one form of protest on my part to the wrongly applied and too prolonged use of immobilizing splints, almost universally employed in the treatment of this injury, to which I was convinced that much of the unfortunate results so often attending this fracture were due. I have treated a large number of broken wrists during the past thirty years without the use of a splint with such good results that they have fully justified me in the practice. Nevertheless, I have not been unmindful of the distinct advantage of the protection which a properly applied splint could give in these injuries, a protection which is more especially called

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for in the presence of much comminution of the lower fragment, and in those cases in which marked displacement demonstrated the association of extensive sprain and laceration of the soft parts.

Whether indeed to the dressing should be added a splint will generally depend upon what may be called collateral circumstances. In cases of those who are young, or are careless, or are apprehensive, the additional protection of a splint is a wise precaution to be used if the surgeon also remembers that its prolonged use may create finger and wrist stiffness and by its pressure deformity may be perpetuated or an ischæmic paralysis may be induced. For a young surgeon also it will in most cases be more discreet not to disregard the popular sentiment as to the necessity of a splint in the treatment of a fracture. If a splint is to be used a light straight posterior splint supplies fully all the indications for splint support and immobilization (Fig. 128). It should not be wider than the wrist itself lest it interfere with the lateral support to the ulna; it should extend from the upper part of the forearm downward only to the heads of the metacarpal bones, so that the fingers shall not be confined by it. It should be well padded. The graduated pad to fill up the concavity of the radius above the articular lip on the palmar side will already have been adjusted as recommended (page 23), shown also in Figs. 127 and 128.

Special support to the ulna should be given by making the palmar pad wide enough to project on the inner side of the wrist sufficiently to enwrap the inner side of the ulna, or by the adaptation of a special pad to support the ulna. Over all should be applied a roller bandage—preferably of flannel—which should leave the fingers and the thumb free. As soon as the primary congestive reaction from the injury has subsided, that is from the fourth day, the thumb and fingers should be frequently and systematically flexed, and after the first week the splint should be daily removed and the wrist should be massaged and moved; by the end of the third week the splint should be discarded altogether, and thereafter active and passive movements of the wrist and fingers, with massage, be practised systematically until the normal function of the parts has been restored.

*Special Forms of Splints.*—Many special forms of splints have been devised for this injury, most of them intended to maintain certain positions of the hand on the supposition that thereby displacements could be corrected or prevented. They are with few exceptions based on incorrect views as to the cause of displacement and disability and none of them possess such special advantage as to justify their description here. An exception to this statement may be made in the case of such splints

as the Coover, the Levis and the Walker splints which are anterior splints molded in such a way as to accommodate the irregularities of the palmar side of the hand, wrist and forearm, and hence tend to lessen the disadvantages of the ordinary straight anterior splint. With proper padding (Fig. 129) they may be made to give the needed support to a fracture without exerting undesired pressure on the anterior face of the lower fragment, and they are comfortable to the patient. One who wishes to use these splints must have a variety of sizes—rights and lefts—to adapt them to various ages and sizes of patients. Their use does not in any degree lessen the importance of first fully readjusting the fractured parts. It is only after full reposition has been secured that they may help in the further care of the case. In 1881 Dr. Coover, of Harrisburg, Pa., sent me a full set of various sized splints, devised by him, so shaped out of a light pine fabric that the thenar eminence of the hand and the normal lateral angle of the hand with the forearm were provided for (see Fig. 130). During the thirty-five years that have elapsed since I received them, I have used these splints many times; I have most of them still in good condition for I have seen to it that they were not carried away permanently by those in whose cases they were used. The manner of their application is shown in Fig. 131.

*Treatment of Fractures Already Healed in Deformity.*—It is not infrequent that fractures of the base of the radius are permitted to heal without adequate effectual attempts at adjustment of the primary traumatic deformity having been made. Every grade of the deformities which have been recognized as due to any degree of this injury may remain as the permanent result. In general the functions of the wrist and hand are ultimately so far restored, even in cases of marked deformity, that all the ordinary activities and possibilities of usefulness of the member are regained. The greatest and most prolonged disabilities are due to adhesions in the tendon-sheaths and among periarticular fibrous structures and to muscular degenerations caused by undue and prolonged splint pressure and immobilization and not to the bony malformation.

In comparatively recent cases, by that I mean at periods of from three to six weeks after injury, there still remains ground for hope that by breaking up the new formed and still soft bonds of union, either by manipulation or by a chisel through an open wound, a better position of the fragments could be obtained and the worst of the deformity removed. When, however, one reflects as to the frequency with which permanent alterations in the texture and contour of the lower fragments have unavoidably resulted from the injury sustained, and also how extensive are the contractures of the periarticular tissues and the rup-



FIG. 130.—The turbinated-split (Coover) for fracture of the lower extremity of the radius and other injuries of the wrist.



FIG. 131.—Palmar turbinated-split applied. Note thenar eminence received in the depression provided for it; note projecting anterior lip of radius secured from pressure by special device adjusted; note support given by encircling adhesive strip to prevent tendency to renewed backward displacement of the lower fragment; note freedom of thumb and fingers for active movement.



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tures of ligaments that cannot be reformed as before the injury, one will not be too sanguine as to the ultimate benefit which he may secure to such a patient by operative interference. In a number of instances I have exposed a badly united fracture line involving the base of the radius by an incision over the dorsum of the radius reaching from the middle of the carpus below upwards as far as required to secure needed exposure and access to the seat of the fracture for the necessary manipulations. By blunt dissection the lower end of the bone can be readily exposed; the periosteo-ligamentous-tendinous flaps can be held aside by retractors, and a chisel used as freely as may be necessary to re-establish the fracture in its original plane. The surrounding restricting fibrous bands will have to be divided with sufficient freedom to make possible the easy replacement of the loosened lower fragment in its normal position and prevent any tendency for it to be drawn again into its faulty position. This having been accomplished, the wound is sutured and the part dressed and cared for as if a recent fracture. The results of such attempt at my hands have been sufficiently good to encourage their repetition in similar cases. I have thought that I have not been sufficiently free in dividing the periarticular fibrous structures in some of them to have secured as perfect a result as might possibly have been attained. I have not had occasion to resect a projecting ulnar head, but it cannot be denied that such a procedure would be indicated in some cases.



# VOLKMANN'S ISCHÆMIC PARALYSIS AND CONTRACTURE\*

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SINCE Volkmann, in 1881, published his first communication on "Die Ischämischen Muskellähmungen und Kontrakturen," much work by many individuals has been done in both the experimental and clinical fields to determine the etiology, pathology and treatment of this condition.

The views expressed by the many writers on these various phases of the subject differ widely.

Inasmuch as this form of so-called paralysis is not uncommon, and especially since its incidence is almost entirely due to bad initial management of injured extremities, it is desirable that an attempt should be made to correlate the varying views as to etiology and pathology and from the resultant findings to deduce the principles of treatment, both of injuries likely to develop this condition and of the condition itself at its incidence and in its fully developed form.

Only those cases occurring in the upper extremity will be considered.

Concerning its incidence it is a matter of record that this condition occurs in children between one and fourteen years of age, and almost always secondarily to fractures about the elbow and upper forearm region, in which the primary treatment is such as to cause serious interference with the circulation plus direct pressure at and below the site of the fracture. This is brought about by tight bandages, splints, or position (acute flexion at the elbow for example).

The different views as to the etiological pathology of the condition may be indicated by the following brief schedule:

1. Primarily muscle changes—Volkmann, Leser.
2. Nerve damage primarily—Chvostek, Mannkopf and Lapinski.
3. Primarily muscle and secondarily nerve damage—Hildebrand.
4. Muscle and nerve damage, simultaneously and co-ordinately—Bardenheuer.

This wide divergence of views probably results from the equally wide divergence in the clinical manifestations of different individuals in the group.

In trying to determine which view is most likely to be correct it is

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\* Read before the New York Surgical Society, November 8, 1916.

## ISCHÆMIC PARALYSIS AND CONTRACTURE

important to remember that in a considerable percentage of the cases the loss of voluntary movement and the rigid contracture of the muscles occur simultaneously (in some cases the contracture starts as late as seven weeks after the injury, but the muscles are rigid and inelastic even before the shortening occurs), and that both the loss of power and contracture occur in the same muscles.

Since the paralysis which follows injury of a nerve is always a flaccid paralysis, a fact beyond dispute, and since the contractures which involve muscles in a partially paralyzed extremity occur not in the paralyzed muscles themselves, but rather in their no-longer-opposed antagonists, it is evident that nerve injury cannot be the prime factor inducing the *condition under discussion*. How important nerve injury, both primary and secondary, is, as a complication, will be indicated later.

Again, Leser has demonstrated experimentally that shutting off the arterial supply of an extremity resulted in flaccid paralysis of the muscles. On the other hand he demonstrated on dogs, that a tight bandage on one of the extremities, without previous injury to nerve or artery, would cause, after five or six hours, a rigidity of muscles with loss of function, quite comparable to the *condition under discussion*. If at the end of the five or six hours, when the extremity had become rigid, the bandages were entirely removed and the dog allowed to run free, complete recovery quickly ensued. If, however, the compression was removed but the dog was prevented from using the extremity, loss of function and contracture developed steadily to full degree. These important observations will be referred to again under the consideration of treatment.

Since nerve injury, or complete arterial obstruction, or both combined cause only flaccid paralysis, which is in no way comparable to the ischæmic paralysis and contracture under discussion, they cannot be considered as essential etiological factors.

It remains to be determined whether primary injury to muscle substance, with the consequent changes, will explain the immediate and remote pictures, both pathological and clinical, which are found in these cases.

Volkman,<sup>1</sup> in his original publication stated that, as a result of interference with arterial supply aggravated by venous congestion, the muscle substance, deprived of its oxygen, underwent coagulation necrosis and developed localized rigor mortis with contracture. As the ischæmia was not complete gangrene did not occur.

Leser<sup>48</sup> and Horwitz<sup>41</sup> have demonstrated that direct compression of the muscles for more than six hours will cause the typical muscle

changes invariably even where there is no damage to the nerves or vessels other than that due to compression, whereas damage confined to the vessels and nerves never caused the characteristic changes. Moreover, in the acute stage, the muscle substance is white, almost as if cooked, and has lost its elasticity and vascularity.

At a later stage when the contracture is developed, the muscle substance is diminished in volume, hard, stiff, dry, yellowish-brown, avascular and inelastic.

In the final stage hard fibrous tissue replaces the muscle substance more or less completely according to the severity of the individual case.

These muscle conditions are entirely different from those found where the arterial or nerve supply or both have been cut off, because in such cases the muscles are flabby, and while degeneration and cicatricial replacement may occur, the result is always an atrophic flabby mass, instead of the stony hard cicatricial mass suggestive of an inflammatory residue, which is always present in the ischæmic cases.

Moreover, the maximum change in the muscles is at the site of the greatest local compression, *i.e.* the flexor aspect of the forearm just below the elbow. Fig. 1 is a photograph of a section taken from the middle of the flexor group of muscles about one-third the length of the forearm below the elbow in Case III. No muscle substance can be made out.

From the preceding facts the deduction is, that the primary underlying condition in these cases is one of direct damage to muscle substance followed by the usual cicatricial changes and contractures.

In addition to this fundamental muscle damage there may occur complicating lesions of the nerves and vessels passing the elbow. When such complicating lesions are present the muscle damage is naturally augmented and recovery delayed or prevented by the interference with the circulation and innervation of the involved muscle.

Of the nerves passing the elbow, one or all may be involved, the ulnar being first in frequency and the median next. The injury may occur primarily as a part of the accident, or secondarily as a result of pressure and ischæmia from the dressings, or more remotely as a result of constriction by the shrinkage of the cicatrized mass of muscle. This nerve damage may vary all the way from complete severance of the nerve to very slight interference with function.

Thomas<sup>27</sup> found evidences of nerve involvement in 62 out of 107 cases he tabulated (about 58 per cent.) in most of which he believed it to be a late development from cicatricial pressure.

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The presence of a complicating nerve lesion renders the prognosis more dubious both as to speed and completeness of recovery.

A serial picture of the stages as they occur in the development of this condition will be most helpful in the consideration of the symptoms, prognosis, and especially the treatment indicated.

One anatomical fact is important; the whole flexor group of forearm muscles is surrounded by a firm, unyielding covering of aponeurosis and bone. The extensor muscles are covered by a similar envelope but they are seldom involved in the process. The flexor group bears the maximum damage, since the muscles form a prominent mass, surround the large vessels and are therefore liable to greater traumatic infiltration. From their prominence, due to both natural size and greater infiltration, they suffer the maximum damage from any form of compression dressing.

When the injury occurs, usually a fracture in the elbow region, there is an infiltration of the soft tissues first with blood and later with œdema which rapidly increases the tension beneath the unyielding envelope just mentioned. Increased tension interferes with return flow in the veins with consequent increasing venous congestion and swelling. Gradually the arterial flow is diminished by the increasing subaponeurotic pressure and there approaches a condition of stagnation in the nutrition of the muscle substance.

If, in addition to these internal disturbances of muscle nutrition, there is added external compression by means of tight splints, bandages or extreme flexion, conditions are ideal for the production of ischæmic paralysis and contracture. Yet, of all the children with fractures about the elbow who are badly treated, only a small percentage develop this lesion. This fact would suggest the possibility of a fundamental deficiency in the muscle nutrition of those in whom it does appear. When once the myositis is fully developed there is a replacement of muscle tissue by connective tissue which contracts and gives the typical end result.

The pathological changes just described may involve only a small portion or the whole of the muscle substance, and between these two extremes there may be any number of gradations. In the same way there may be any number of variations in the amount of injury, both primary and secondary, to the nerves and vessels.

To keep these facts clearly in mind, is of prime importance in the consideration of prognosis and treatment.

The symptoms are characteristic, and may be considered as immediate and remote.

Immediate: When the fractured arm has been cared for and put up in a tight dressing, the child soon complains of pain, which is so persistent and severe as to prevent rest or sleep, day or night, and to cause constant outcry, which is usually explained as resulting from a highly nervous temperament, since all fractures are painful the first few days.

Accompanying, and sometimes slightly preceding the onset of severe pain, there is a rapid swelling and cyanosis of the fingers, hand, and forearm.

In the more severe cases large blebs appear on the exposed areas of skin, while skin sloughs appear at the points of maximum pressure of the dressing, being most common on the flexor surface of the forearm just below the elbow and on the ulnar side at or just above the wrist.

If, in spite of the above symptoms, the dressings be left undisturbed, the pain and swelling gradually disappear after the first few days. During the height of the pain and swelling, there is often marked constitutional disturbance as indicated by a temperature from  $102^{\circ}$  to  $104^{\circ}$  F., headache, malaise, anorexia, etc.

The characteristic changes in the muscle substance occur in from five to forty-eight hours, depending upon the amount of subaponeurotic swelling and degree of external compression applied.

When the muscle change has occurred, it is indicated by loss of voluntary motion, by more or less rigid resistance to passive motion, and, if the dressings are removed, the whole muscle mass has a hard, brawny feeling beneath the finger.

The flexion contracture of the fingers may start within six hours, or it may not begin until as late as six weeks. In either case it is progressive over a period of about three months, after which there is practically no further shortening of the muscles involved. From this point on there may be a gradual increase in the flexion deformity, as a result of the steady growth in the length of the bones with no compensatory increase in the length of the cicatrized muscles.

In the early stage, the contracture shows itself in the form of marked flexion of the second and third phalanges, with extension at the metacarpophalangeal joints. As the contracture progresses this deformity is exaggerated and there is added an increasing flexion of the wrist and a slight flexion of the elbow in semipronation.

The characteristic feature of these cases when well developed lies in the behavior of the fingers and wrist toward passive motion. If the wrist be forced to the fully flexed position, the fingers can be passively

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(and oftentimes voluntarily) extended to a straight line. If now the fingers be held fully extended, extension of the wrist joint is found to be impossible unless sufficient force is used to rupture the flexor tendons. On the contrary, every degree of wrist extension is accompanied by a corresponding amount of flexion in the fingers, until extension at the wrist is limited by the full flexion of the fingers and this point is usually reached before the wrist has been quite extended to a straight line.

During these manipulations the flexor tendons stand out at the wrist and in the forearm like whip-cords. The upper forearm is much diminished in size, and the mass of flexor muscles is more or less completely replaced by a smaller, hard, inelastic mass of cicatricial tissue, obviously the cause of the changes in the mechanical possibilities of the extremity.

When the initial dressing has produced skin sloughs either just below the elbow or at the wrist, as previously mentioned, infection usually occurs, and produces discharging wounds which are many weeks in healing because of impaired nutritional conditions.

In some cases the infection penetrates into the muscles of the upper forearm, or among the tendons at the wrist-joint, adding materially to the muscle damage and later cicatricial fixation of the extremity.

Thomas<sup>27</sup> in his series of 107 collected cases found scars from sloughs present in 37 cases. Symptoms due to nerve complications occurred in 62 out of the 107 cases in the same series. The ulnar and median nerves are the ones involved as a rule.

The damage to these nerves may be primary at the accident, in which case there will be a loss of function, sensory and motor, corresponding to the extent of damage to the nerve substance.

The nerve damage may be secondary to the pressure produced by the infiltrated muscles and tight dressings, the effect being enhanced by the ischæmia. In this case nerve function is apt to be diminished in activity rather than abolished, although entire loss of function may occur in extreme cases.

Finally nerve damage may occur after several weeks, when it is due to pressure from cicatricial contracture of the involved muscles. Here again, function is more apt to be impaired than totally lost.

In both the ulnar and median nerves loss of motor power can be made out only by an examination of the intrinsic muscles of the hand which are not involved by the "ischæmic process," whereas all the flexor muscles in the forearm have lost their voluntary motion because of

their intrinsic disease, whether or not their motor nerves have been damaged.

The ulnar nerve supplies all the intrinsic muscles of the hand except the abductor pollicis, opponens, and outer half of flexor brevis pollicis which are innervated by the median.

With the long flexor tendons in a state of rigid contraction it is obvious that any examination of these small muscles must be difficult and very unsatisfactory in results, especially in young children who have recently undergone the hard process of acquiring the deformity.

Determination of the condition of the ulnar nerve is less difficult because almost any child will try to separate and approximate the fingers, and the power to do this indicates an intact ulnar supply to the interossei muscles.

In the later stages of the condition, atrophy of the thenar, hypothenar, and interossei muscles would indicate at once serious damage to the corresponding nerve.

Careful repeated examinations of sensation give reliable evidence as to the condition of the nerves, diminution or loss of sensibility indicating corresponding degrees of damage. Repeated examinations are necessary because young children are inconsistent in their responses to stimuli, so that an average must be arrived at.

Nerve injuries are followed also by trophic disturbances, evidenced by the thin glossy skin, coldness, cyanosis, which are most marked in the fingers, as well as by the thickened, brittle, cross-ridged nails. Ulcerations appear at the finger tips upon the slightest provocation.

The difficulties of a neurological examination are greatest and the results least satisfactory during the primary stages of the condition, in addition to which the many troubles of the practitioner prevent him from thinking of it, so that records are usually lacking.

In general terms, the prognosis is distinctly unfavorable and is rendered more so in proportion to the amount of muscle substance which has undergone disintegration and will therefore be replaced by cicatricial tissue.

When present, skin sloughs followed by infection and slow healing sinuses, and nerve injuries of greater or lesser degree, add unfavorable elements to the outlook, as does delay in starting appropriate treatment.

To give an accurate prognosis at the start in the individual case is very difficult, because it is scarcely possible to determine the exact extent, degree and distribution of the injuries to the muscles, nerves and vessels. This statement applies as well to the early stages of the fully developed contractures (see Case II).

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As previously emphasized the muscle damage may vary anywhere from complete degeneration and cicatrization of all the muscle substance, to a very mild degree of damage. It is obvious that complete degeneration and cicatrization would give an absolutely hopeless prognosis, regardless of treatment, and that a very mild degree of damage would give a good prognosis, almost regardless of treatment.

In the intermediate grades the prognosis depends essentially upon the amount of muscle damage but is more definitely influenced by proper treatment. The great majority of cases belong to the intermediate grades.

The great difficulty lies in determining clinically just how much muscle has been involved, because a small amount of cicatricial tissue properly distributed will cause the marked contracture deformity and rigidity characteristic of the condition, and will resist completely any justifiable amount of force used in an attempt to cause passive extension of the fingers and wrist. Resistance to passive extension, then, is not a reliable criterion.

Palpation of the flexor muscles in the upper forearm may help somewhat, since, in the milder cases, they do not present so solid an induration. Here, also, however, an element of error is present because the deep aponeurosis of the forearm is so often thickened as to give a resistance which obscures the feel of the mass beneath it.

In the small proportion of cases in which the electrical tests can be made satisfactorily, a positive reaction by the flexor group to either current would indicate the presence of some uncicatrized muscle and therefore improve the prognosis. On the other hand, cicatricial tissue may be in such preponderance as to prevent any evidence of reaction on the part of viable muscle which is still present.

These difficulties in relation to prognosis are well illustrated by Case II in which one of our best known surgeons said that the only hope lay in resecting both bones of the forearm and even that gave but little prospect of a useful hand. However, to the surprise of every one concerned, without any operation, there was a practically complete recovery after six weeks of treatment. That could mean only that the muscle damage was nothing like as extensive as the clinical examination seemed to indicate.

Nerve damage adds an element of delay to recovery, and if the nerve is not successfully repaired there is a corresponding permanent failure in recovery.

Likewise damage to the great vessels of the extremity delays and may permanently impair recovery.



Great delay in instituting proper treatment is unfavorable since old, firmly contracted cicatricial tissue is more difficult to influence, and old nerve injuries are somewhat less satisfactorily repaired.

It seems clear that an accurate prognosis cannot be formulated in the individual case, and that a fair estimate of the final outcome can be given only after a considerable period of appropriate treatment.

To evolve a rational method of treatment it is necessary to appreciate:

That the fundamental disturbance is a traumatic myositis, accompanied by marked infiltration and œdema in a group of muscles confined in a close fitting inexpandible envelope of aponeurosis and bone, aggravated by external compression:

That the muscle substance is replaced to a greater or less extent by connective tissue which contracts and causes the characteristic deformity:

That the nerves and vessels may be more or less injured:

That, clinically, it is difficult if not impossible to determine the exact amount of damage present in the individual case.

Prophylaxis is of great importance. As a general principle fractures should be reduced and immobilized at the earliest possible moment after their occurrence, and this principle applies to the group under discussion. However, there should be special precautions in dealing with all fractures about the elbow region in children. Manipulation should be gentle, to avoid additional traumatism and swelling. Fixation in extreme flexion is dangerous because of circulatory disturbance both in veins and arteries. Where it seems essential very frequent observation is imperative.

Splints should be padded so as to avoid localized pressure spots.

Dressings should not be too tightly applied. They should allow for increasing œdema. The extremity should be elevated.

Once reduction and fixation have been accomplished, the extremity should be watched with the greatest care. For the first forty-eight hours, inspection by the attending physician every five or six hours would be the ideal arrangement, since the condition may become fully developed in that period. This plan is seldom feasible. Next best is to have the parents instructed to call the physician at once, if there is unusual and persistent complaint of pain which prevents sleep, and especially if the pains are accompanied by cyanosis, swelling and possibly some rigidity of the fingers.

As soon as this combination of symptoms makes its appearance, all dressings should be removed, the elbow placed at a right angle or

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more to aid circulation, the extremity elevated, and the site of fracture firmly supported by hand, while gentle massage is given from the fingers upward, followed by passive motion applied to the fingers and wrist. (Active motion if the child is able. See Leser's Experiments on dogs.) All these procedures aim to reduce the swelling and improve the circulation and nutrition of the muscle substance which is threatened with degeneration.

If the swelling diminishes, or at least does not increase, and especially if there is less pain, and the cyanosis and rigidity of the fingers are lessened, the extremity may be lightly fastened to some support and left in the elevated position. For the time being the fracture itself is of secondary importance, the chief care being to give enough support to avoid further injury to the soft tissues by the bone fragments, and to leave the limb in position for the best circulation.

In some cases, if not in all, a general anæsthetic would seem advisable for the above procedure.

If, in spite of the treatment just outlined, the pain, swelling, cyanosis and rigidity increase, we are dealing with a group of muscles under great compression beneath the unyielding deep aponeurosis, threatened with disorganization, and the only hope lies in applying the principle of decompression. If the skin itself is not much involved by the swelling, a subcutaneous split may be made in the aponeurosis over the whole length of the flexor muscle bellies from the elbow down. If the skin is hard, brawny and shiny, it should also be split full length with the aponeurosis. Sterile dressings are applied without pressure. Of course, general anæsthesia and all aseptic precautions must be used.

After the dressings are applied, gentle passive motion of the fingers and wrist should be given, to help restore the muscle nutrition, while the patient is recovering from the anæsthetic.

Up to this point nothing can be done for nerve injuries, even if they are known to have been caused at the accident, because of the unfavorable condition of the tissues.

The treatment thus far outlined has never been applied to the living human subject, but it seems logically to follow from the consideration of the progressive pathology of the condition and of the experiments of Leser and others.

While splitting the aponeurosis has not been done in the acute stage, as suggested by the late Dr. Murphy in a recent communication,<sup>47</sup> the application of the principle 18 months ago in a fully developed case

of long standing (Case III) seemed to help materially in the improvement.

The reason for treatment, up to this point, remaining in the theoretical stage is obvious from the average history in these cases, *i.e.* injury, more or less prompt reduction and tight fixation, absence of the practitioner for a week or more, oftentimes in spite of reports as to pain, swelling and cyanosis. When the dressing is changed after the lapse of a week the fully developed condition is found.

Treatment from this stage onward has developed along two lines:

i. The relief of the contracture deformity by operation which consists in (a) the lengthening of the tendons of the contracted flexor muscles. This is by far the most popular operative method. In the lower forearm the tendons are lengthened sufficiently (one, two or more inches) to permit simultaneous full extension of the fingers, hand and wrist. The tendons are lengthened at slightly different levels to avoid massive adhesions, and are individually surrounded by Cargile membrane for the same purpose.

(b) The resection of both bones of the forearm so as to shorten them sufficiently to permit simultaneous full extension of fingers, hand and wrist.

These two methods merely rearrange the mechanical relations between the contracted muscle-tendon units and their bony points of origin and insertion. This relieves the deformity but can scarcely be credited with causing the return of voluntary activity in the damaged muscles. Moreover, if either of these operations be done, and the extremity is allowed to go without vigorous after-treatment, there is a slow but sure return of the deformity as the steady growth of the bones of the forearm again lengthens the distance between origin and insertion of the still cicatrized muscles. This actually occurred in Case I in the course of a year.

In the successful cases reported after these operations, there is always reference to the vigorous use of all the means of physical therapeutics over periods varying from weeks to months and even years, so that it is reasonable to inquire how much is due to the operation *per se* and how much to the after-treatment.

To repeat once more, the essential lesion consists in the change of muscle to cicatricial tissue. If this change involves every bit of the muscle, no treatment, operative or otherwise, can ever restore active motion to the damaged muscle. If the damage involves only a portion of the muscle, the remainder is potentially able to cause voluntary motion provided it can be freed from the handicap of the con-

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tractured cicatricial tissue mingled with it. The problem then resolves itself into finding the best means of removing the cicatricial handicap.

It is difficult to see how either of these operations could act in that way. Moreover, if they do, why is there the necessity for prolonged systematic physical therapeutics afterward?

If the tendon of a normal muscle is lengthened, the functional value of the muscle is diminished and the range of motion is lessened in proportion to the lengthening of the tendon. The same principle must hold true in the damaged muscle, so that these operations would seem to diminish somewhat the potential value of such muscle as is still viable.

In the tendon lengthening operation there is an increased risk of infection because of the defective nutrition, and there is the chance of adhesions among the tendons.

In the bone resections a number of cases of non-union have been reported.

Because of the many disadvantages of the operative methods there has been evolved:

2. The relief of the contracture deformity by mechanical stretching combined with systematic physical therapeutics.

(a) Robert Jones of Liverpool<sup>16</sup> for years has advocated this method because of the greatly improved results he has obtained, with the avoidance, at the same time, of the risks of operation.

Sayre<sup>21, 26, 29</sup> in this country has repeatedly emphasized the value of the method.

His method consists in cutting from sheet iron or zinc a small splint for each digit. When the wrist is forced into complete flexion, and the fingers can therefore be fully extended, each finger is bound to its individual splint and so maintains complete extension. The wrist is freed and the patient told to work at extending the metacarpophalangeal joints. After a few days, when this can be done, a splint is bound on from finger tips to wrist, covering the previous finger splints and maintaining full extension. The patient now works at extending the wrist and when this is finally accomplished a third splint is applied over the others from finger tips to elbow and holds all the intervening joints in a straight line.

The splint is bent from time to time to increase extension at the wrist until it is complete, and is then left in place for weeks, until there is no tendency to recurrence of the contracture when all restraint

is removed. Finally a systematic course of massage is given until all the improvement possible is obtained.

This method is sound in principle because it overcomes the contracted cicatricial handicap by means of stretching and physical therapeutics, and leaves such muscle tissue as is still viable free to regain its full functional value.

However, the superimposing of rigid splints covers the fingers in such a way as to prevent inspection readily, and to prevent the use of massage, heat, passive motion, etc., in the early stages of the treatment.

The fingers are especially liable to develop pressure sores because of their defective nutrition and innervation and, therefore, they should be exposed for inspection. The early institution of physical therapeutics is certainly of great value.

These considerations led to the adoption of the apparatus and technic used in all but one of the small group of cases appended. This might be called—

(b) *The elastic traction method* of overcoming cicatricial contracture. (A method which may be adapted to overcome almost any type of cicatricial ankylosis or contracture.)

As may be seen by reference to Figs. 2 and 3, the essential feature lies in putting the traction of rubber elastic against the resistance of the contracted cicatricial tissue.

Its advantages are numerous:

The pull can be graduated to any degree suitable to the individual case, and can be varied by changing the number or tension of the rubber bands.

Just as soon as the contracture yields a little, the rubber takes up the give and keeps on pulling.

A moderate tension on the rubber bands will cause a prompt, steady, persistent, and practically painless stretching of the contracted tissues.

The child's attendant is readily taught to apply and adjust the brace, so that it may be removed once or twice a day for massage, etc., from the very start, so that inspection for pressure spots is a matter of routine twice a day. Visits to the surgeon need be only at infrequent intervals.

The details of treatment in all except the first of the group of cases appended, were as follows:

The brace was made on a plaster of Paris model of the forearm so as to fit smoothly. It was applied without lacing it so tightly as to interfere with the circulation.

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Elastic traction was applied up to the point of moderate discomfort.

The apparatus was left on continuously except for two intervals of an hour each, morning and afternoon. During these periods, the whole extremity was immersed in hot water for twenty minutes, kept as hot as bearable by constant addition of hot water.

If nerve involvement is present the heat must be less and the attendant's hand should be used as a guide.

After the immersion, massage and vigorous passive motion were used, and, finally, attempts at voluntary motion were encouraged. It is remarkable how greatly this prolonged use of heat increases the stretchability of the contracted tissues even if only temporarily at first.

When the contracted tissues have been well stretched, so as to permit a good degree of passive extension of fingers and wrist simultaneously, the apparatus has been left off during the day so as to encourage active motion and use, and then worn during sleep to avoid recurrence of the contracture.

As the tendency to recurrence has disappeared the apparatus has been used less and less until it has finally been discarded. The child is systematically trained to use and develop all the muscles which have survived.

By either of the extension methods the contracture can be overcome so that the fingers, hand and wrist can be simultaneously fully extended, which accomplishes the same result as either operative method per se.

If, now, there is any viable muscle tissue left in the flexor group, it can be brought back into voluntary activity by the same methods of physical therapeutics as must always be used after operation to get the results.

If no viable muscle tissue is left, then voluntary motion cannot be restored by either method, and the only result is mechanical relief of the deformity. The time required for non-operative extension varies from a few weeks to a number of months, varying with the amount of cicatricial tissue and the length of time the contracture has existed.

The extension method, therefore, offers as much prospect of recovery as the operative method, and at the same time avoids the pain, risks and expense incident to operation.

Decompression applied to the flexor group of muscles by means of splitting the deep aponeurosis freely may prove to be a very helpful

procedure in the more severe cases, although at present the clinical evidence is insufficient to justify any conclusion.

Nerve injuries occur primarily or secondarily, in about 60 per cent. of the cases, as previously mentioned.

When there is simply a diminished activity of the nerve, no operative interference should be considered until the contracture has been overcome, because it has frequently been observed that during the process of stretching out the contracture, the symptoms of interference with nerve function also disappear (see Case II).

If, however, these symptoms persist after the contracture is overcome, the nerve or nerves should be explored in the fracture area and throughout their involvement in the cicatricial tissue, and such damage as is found should be repaired by appropriate means, suture, neurolysis, transposition, etc.

When the original injury has divided one or more nerves (and this, for reasons previously given, is seldom discovered promptly) operation is contra-indicated during the acute stage of the myositis and until any infected pressure-sloughs have been thoroughly healed. Then the damaged nerve should be repaired without further delay.

CASE I.—L. K., five years old. On May 5, 1906, he fractured the lower end of the right humerus.

One hour later the extremity was put up in a circular plaster splint. Soon there was great pain, swelling and cyanosis of the hand. Large blebs formed on the hand.

On the 7th day (May 12) the splint was split on two sides and lifted off. There was an abscess on the flexor aspect just below the elbow. Voluntary motion was lost in the fingers which were rigid. After dressing the abscess, the two halves of the splint were replaced and bandaged on.

At the end of four weeks (June 2, 1906) the splints were left off entirely. There was then a well developed ischæmic contracture. On the supposition that the paralysis was due to involvement of the musculospiral nerve by callus, exploration of the nerve was made and it was normal.

For the succeeding year massage, electricity, vibration, etc., were used with no result. The hand was useless. On June 24, 1907, he was brought for consultation. There was the deformity of fracture of the external condyle of the right humerus, and the scar resulting from exploration of the musculospiral nerve. The scar from the flexor abscess just below the elbow was 4x2 cm. The right forearm, wrist and hand showed typical *main-en-griffe* and the rigid fingers could not be extended actively nor passively.

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The flexor muscles formed a rigid cicatricial mass, which prevented extension of fingers and wrist, and also complete extension of the elbow. The extensor muscles could be made to contract voluntarily but they caused no motion in the fingers because of the extreme flexion contracture. The hand was cold, and blue, and the skin was shiny. There were trophic disturbances of the finger ends, especially of the middle and index fingers. There was atrophy of the interossei, the thenar and hypothenar muscles.

On July 6, 1907, fourteen months after the injury, operation was done under ether. The median nerve, exposed by an incision through the cicatricial flexors, was found to be compressed, thin and white for a length of 5 cm. just below the elbow. A canal was made for it through the cicatrix and it was surrounded by Cargile membrane. The ulnar nerve, also exposed, showed less evidence of compression. It was treated as was the median. The wound was closed without drainage. The superficial flexor group was almost entirely cicatrized and scarcely bled when cut. The deep flexor group showed some remaining muscle substance. About 3 cm. were resected subperiosteally from the lower thirds of both the ulna and radius. The bones bled freely. The periosteum was so elastic that there seemed no redundancy when the bone ends were approximated. An aluminium ferrule was slipped over the ends of each bone beneath the periosteum to maintain good alignment, and the wounds were closed. The fingers, hand and wrist could be readily extended to a straight line and were put up in an anterior splint.

August 24 (7 weeks after operation) the splint was removed. There was firm union in each bone, with fusiform swelling over the aluminium ferrules. Fingers and wrist could be fully extended.

October 30, 1907 (3 months and 24 days). There was some return of flexion contracture of the wrist and fingers; and some action of the interossei. The thumb could be adducted and slightly flexed. The hand showed improvement in warmth, color and nutrition (nerve regeneration).

February 3, 1908 (7 months). More contracture deformity. Atrophy of the intrinsic muscles of the hand was much less marked. The trophic disturbances have disappeared. The thumb could be adducted, slightly flexed, and could grasp strongly. The little finger could be slightly flexed voluntarily. All the digits could be slightly extended voluntarily. The cicatricial flexor mass was less hard, and the elbow could be extended more fully than before operation. The swelling over the site of resection of the radius was entirely gone, but that on the ulna was still marked.



March 6, 1908 (8 months). The swelling on the ulna was much smaller.

The fingers were more freely movable, and could be slightly flexed by the long flexors. Extension was stronger. The intrinsic muscles of the hand were developing rapidly. The thumb had a strong grasp against the forefinger.

At this time the boy passed from observation.

This case shows that growth of bone gradually caused a reproduction of the deformity, as it must always do, unless the cicatricial mass is stretched and softened so that growth may equal that in the bones.

The great value of nerve exploration is indicated.

CASE II.—M. H., six years old. On June 20, 1911, he suffered a fracture of the lower third of the left ulna. Within two hours the forearm was put up in padded wooden splints firmly bandaged on from the elbow to the fingers. In an hour extreme pain developed, followed by great swelling and cyanosis of the hand and fingers. The pain was so severe as to cause delirium during which he bit the splint, his fingers, etc.

In spite of several reports to the physician of the progress of events, the boy was not seen until the fourth day when the dressing was removed and the fingers were seen to be rigid. Also there was a large slough and abscess on the flexor surface of the forearm below the elbow. After three weeks of daily dressings the abscess was healed. Meanwhile the contracture, which had been in evidence on the fourth day, rapidly developed to the typical attitude (Fig. 5). Nothing was done for the essential condition.

Toward the middle of August the mother noticed that a pin-prick, in the ulnar distribution in the palm, which was deep enough to draw blood, was not felt. Further investigation showed the whole ulnar area of the hand to be anæsthetic, and the median area to be hypæsthetic.

They then consulted one of our most competent surgeons who said it was a very severe case of Volkmann's contracture, that the only hope lay in shortening both bones of the forearm and that even operation held out but little prospect of giving a useful hand and forearm.

On August 16, 1911, he was brought to me with the above history. Examination showed a typical well-marked contracture deformity (Fig. 5). There was no active motion in the wrist or fingers. Flexion of the wrist and fingers could be increased passively but the rigidity almost completely prevented extension.

The site of the fracture in the lower third of the ulna could

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be plainly made out, union was solid and the alignment was good. A hard mass extended from the point of union over to the radius, interfering with supination and pronation.

On the flexor surface of the forearm just below the elbow was the healed scar of the abscess, about 4 x 2 cm., and beneath and connected with it the whole group of flexor muscles was one hard rigid mass.

The entire area of ulnar nerve distribution in the left hand was anæsthetic. The median area was hypæsthetic.

The skin of the fingers was thin, shiny, and the hand was cold and cyanotic, the nails were cross-ridged, and there was atrophy of the intrinsic muscles of the hand.

It looked like a very severe case of contracture with complicating nerve lesions, and the prognosis seemed absolutely bad.

The disappointments following the operative treatment of Case I, had caused the theoretical evolution of the Elastic Traction Method previously described.

Treatment by this method was started August 20, 1911, with the brace shown in Fig. 3, combined with the various methods of physical therapeutics.

Within four days the contracture began to yield to the traction and from that time on progress was rapid.

On August 29 it was necessary to change the angle of the brace to get more extension. He was beginning to move the wrist and fingers, which could be passively extended beyond a straight line simultaneously.

He was not seen again until October 7 (48 days after starting treatment), at which time the hand had become nearly normal in color, warmth, and sensation, and the intrinsic muscles had gained volume.

The cicatricial mass of flexors had softened remarkably, although they still restricted *active* extension of the wrist to slightly beyond a straight line. Passive extension could be carried almost to normal. The fingers could be moved with fair freedom. (The parents reported that within two weeks of starting treatment sensation had largely returned to the hand, the fingers were moving fairly freely, and that the color, warmth, etc., were much more natural.)

At the end of December, 1911, they reported him to be perfectly well.

On October 18, 1916, five years after treatment, the condition is as follows: The fingers and hand are normal in size, nutrition and sensation. All motions are free, strong and normal, except that the extension of the wrist is limited slightly (see Fig. 10). To passive motion the wrist extends further but there is a sense

of resistance not felt in the normal hand. He plays the piano and violin and recognizes no limitation in usefulness (Figs. 5, 6, 7, 8, 9, and 10).

This case demonstrates perfectly that the pathological lesions were not at all as serious as the clinical findings seemed to indicate, and that accurate prognosis is almost impossible at the start. Any form of operation, in this case, could only have prejudiced the result.

The fracture was unusually low and the muscle damage must have been chiefly from direct splint pressure.

Attention is also called to the very rapid improvement of complicating nerve lesions (which seemed very serious at the start) as the contracture yielded to the stretching.

CASE III.—G. H., four years old. On February 9, 1914, she fell and fractured the right humerus just above the condyles. Within two hours, under ether, reduction was attempted and the arm put up at a right angle with shaped wooden splints. The following day, under chloroform, the splints were removed and the elbow was held at much less than a right angle by adhesive plaster dressing. Within two hours great pain occurred together with marked swelling and cyanosis of the hand. The angle of the elbow was then made less acute. That night she had high fever and delirium. The following day the pain was less and the temperature was normal. On the fourth day after the accident she developed a temperature which, for ten days, ran between 101° F. and 102.5° F. Pus was then seen to ooze from the region of the wrist. Removal of the dressings revealed a large abscess on the ulnar side of the wrist and another just below the elbow on the flexor surface. Daily dressings were done and the elbow kept at slightly less than a right angle.

Three weeks after the injury the arm was placed in a sling. It was discovered that the elbow was stiff. Four weeks after injury it was noted that the hand was totally paralyzed. The mother had noticed that there had been no voluntary motion in the hand or fingers from the time of the accident.

The fingers did not stiffen or contract till toward the end of March, nearly seven weeks after the accident.

On April 8, 1914, two months after the accident, when she was first seen, the conditions were as follows:

She was a sturdy, well-nourished child, highly nervous from her recent experience.

The right elbow showed normal relations between the bony landmarks. There was a firm bony mass projecting forward

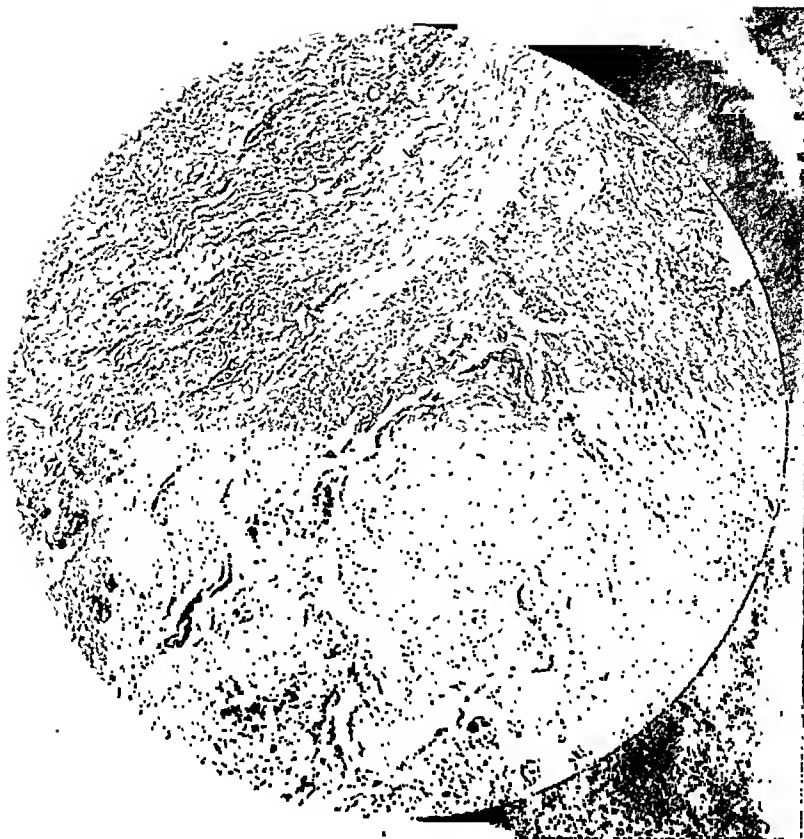


FIG. 1.—Photomicrograph of a section from the middle of the flexor group of muscles, about 4 cm. below the elbow in the median line in Case III. No muscle fibres appear, and the connective tissue is not disposed in an orderly manner.

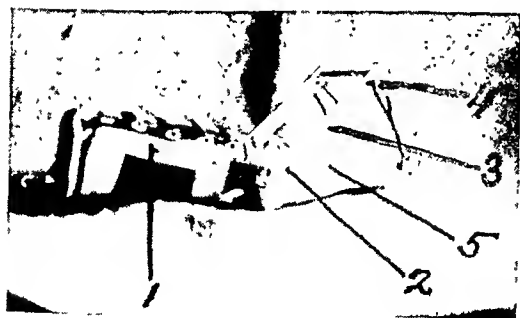


FIG. 2.—1, the sleeve portion of the brace extending from the elbow to wrist, made of steel and leather; 2, an adjustable joint so that the direction of the traction may be changed as improvement occurs; 3, adjustable offset; 4, projecting knob to hold the elastic loop running to 5, a pad to which the hand and fingers are bound when in full extension. This is done after the primary stretching is done as in Fig. 3.

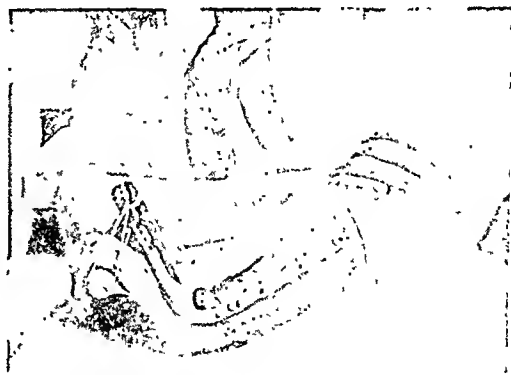


FIG. 3.—This is the original brace made for Case II, applied to his arm five years after its primary use, just to show the wooden cylinder under the fingers, instead of the pad. This brace has no adjustable joint at the wrist like the improved one in the preceding figure. The brace originally reached from the wrist to the elbow, so that its present application shows the result of five years of growth in the forearm.

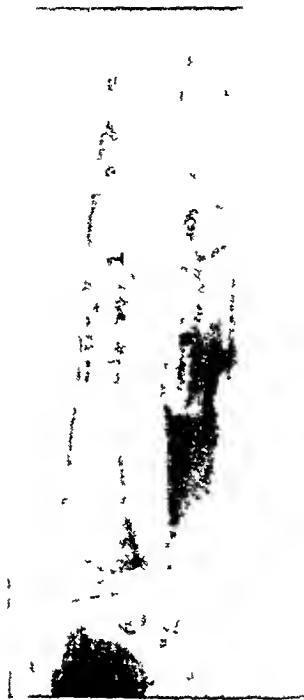


FIG. 4 —X-ray taken nine months after operation for ischaemic paralysis. 1, site of resection of the radius, showing the aluminum tube still in the callus, 2, site of resection of the ulna, showing the tube more distinctly and a larger callus. The perfect alignment of both bones obtained by using the tubes is clearly shown.

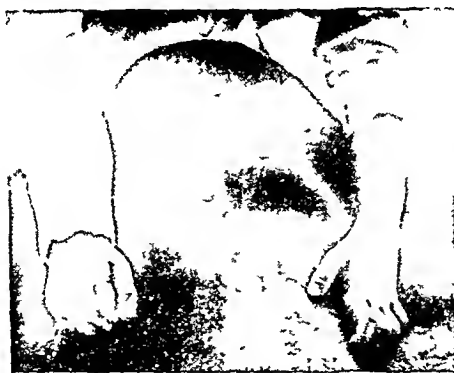


FIG. 5.—Case II. Taken just after the beginning of treatment, when there had already been some stretching of the contracted tissues.



FIG. 6.—Shows the easy natural position of the left hand and its normal size. Figs. 6 to 10, inclusive, were taken October 18, 1916, five years and two months after treatment began.



FIG. 7.—Shows power of spreading the fingers, complete recovery of the interossei.



FIG. 8.—Complete supination of hand and forearm, adduction of fingers and full abduction of the thumb.



FIG. 9.—Firm fist showing power of flexor muscles.



FIG. 10.—Extension of wrist, showing slight limitation on the left side. Passively the wrist can be fully extended. He plays both violin and piano.

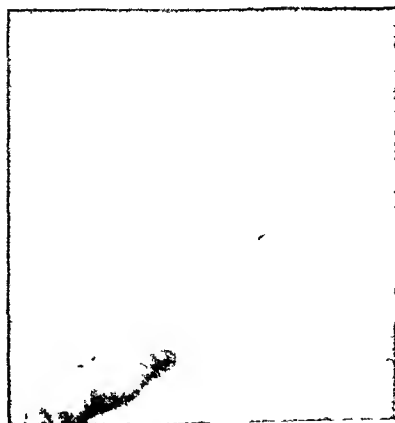


FIG. 11.—Case IV. Showing original position.



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from the humerus just above the elbow and just to the inner side of the median line of the humerus.

The scars of the old abscesses were present on the ulnar side of the wrist and on the flexor surface of the forearm, just below the elbow, to which was adherent the cicatricial mass of the flexor muscles.

There was the typical deformity of Volkmann's paralysis.

Motion. Active. The elbow could be flexed to  $45^{\circ}$ , the limitation seeming to be due to bony contact, and extended to  $145^{\circ}$ , the limitation being due to the contracted flexors. The wrist, starting from its position of marked flexion contracture, could be very slightly flexed and extended. The fingers showed the slightest suggestion of flexion and extension. The thumb could not be moved. The interossei showed no action. Passive. Elbow as above. The wrist could be fully flexed; could be extended not quite to a straight line provided the fingers were allowed to flex completely. The fingers could be fully flexed; could be extended about three-fourths straight with the wrist fully flexed, and about one-third straight when the wrist was held in extended position. The thumb clung closely to the index finger and could be abducted with difficulty. Pronation of the forearm was normal. Supination about three-fourths normal. There was atrophy of the intrinsic muscles of the hand. Sensation. There was anæsthesia in the distribution of the ulnar nerve to the hand and fingers. There was hypæsthesia in the distribution of the median nerve to the hand and fingers. Radial sensation was normal. The flexor muscles below the elbow formed a firm, hard mass, smaller than normal and very adherent to the overlying scar.

Treatment was started on April 13, 1914. On May 27 (6 weeks later), the fingers, hand and wrist could be simultaneously extended (passive motion) almost to a straight line. There seemed to be very slight improvement in ulnar sensation, but no improvement in active motion.

The evidences of serious nerve damage, with the history of motor paralysis at the time of the accident, together with the bony projection just above the front of the elbow were strong indications for exploration.

On July 14, 1914, exploration was done in another city, after which the following information was received. A long anterior incision exposed the bony prominence which was a spicule projecting from the lower end of the upper fragment of the humerus. Further dissection showed that this spicule had pierced the median nerve and severed about half of it. Everywhere, at and below the elbow, there was dense scar tissue. The damaged median



nerve was sutured without removing the end-bulb on the proximal stump. The spicule of bone was removed. The extremity was dressed with the elbow at a right angle.

November 15, 1914. The elbow could be flexed to  $45^{\circ}$  and extended only to a right angle. The scar of the incision was keloidal in character in spite of healing by primary union. There was no change in the median nerve area.

May 8, 1915. The median nerve had shown no signs of regeneration. There was complete atrophy of the intrinsic muscles of the hand. The skin was thin, shiny and cold. The nails showed transverse ridges. There was no improvement in the mobility of the elbow.

May 10, 1915. Operation by the author.

The ulnar nerve was exposed behind the inner condyle and down into the forearm. Behind the condyle it was much swollen and congested for a distance of 2 cm., above and below which it was normal in appearance. It was lifted from its groove and transplanted into the subcutaneous fat in front of the condyle, to relieve it from the pressure of the condyle which had been displaced backward at the time of the accident, and had caused the neuritis. For a distance of 6 cm. below the condyle there was fairly good muscle tissue which contracted feebly to the faradic current. This gave a hopeful aspect to the prognosis. The wound was closed with silk.

The median nerve was explored through the old incision. There was dense fibrous tissue everywhere. The deep aponeurosis of the forearm was very thick and showed the silk sutures of the previous operation. The division of the aponeurosis exposed the proximal bulb of the median nerve to which everything around was quite adherent. From the lower end of the bulb ran a thin cicatricial cord downward to the distal part of the nerve.

Transverse sections were made above and below until good nerve bundles were encountered (about 2 cm. in all being resected) and then the ends were apposed by means of silk side-hitch sutures. Complete apposition was obtained without strain on the sutures. The junction was surrounded with Cargile membrane.

The deep aponeurosis of the forearm was split downward for a distance of 7 cm. below the elbow and left open for decompression. The flexor muscles (except for those near the inner condyle previously mentioned) seemed completely fibrous. A small section was removed. (Fig. 1.) The skin was closed with silk and the arm put up with the elbow at slightly less than a right angle.

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July 1, 1915 (52 days after operation). The color and temperature of the hand and the trophic condition of the fingers and nails were much improved. The atrophy of the intrinsic muscles of the hand was unchanged.

There was voluntary flexion of the wrist for  $30^{\circ}$  from the straight line. There was extension through the same arc. There was definite but slight flexion of all the fingers. The cicatricial mass below the elbow was much softer and motion occurred in it when attempts at flexion were made.

May 12, 1916 (1 year after operation). The wrist could be actively flexed and extended through an arc of  $90^{\circ}$  (of which  $30^{\circ}$  was back of a straight line) and could be adducted easily. The fingers could be extended almost to the straight line with the wrist straight, and could be flexed actively but with very slight power. Extension was followed by a flexion produced by the natural spring-back of the contractured tissues, but in addition there was a very slight positive flexion. The fingers could be ab- and adducted fairly well and the thumb very slightly. The flexor group below the elbow had changed from the old indurated mass to one of soft consistency, which was, however, much smaller than the normal group of muscles should have been. There had been no improvement in motion at the elbow. Extension beyond a right angle seemed to be limited by a bony contact. Supination was very limited, the hand being held in the almost fully pronated position.

Stereoscopic X-ray pictures of the elbow showed a bony outgrowth from the posterior border of the capitellum which interfered with extension beyond a right angle, and probably interfered with supination.

Sensation is almost normal in the entire hand.

July 13, 1916 (14 months after operation). Pinpricks were accurately localized everywhere in the hand and fingers. There was hyperæsthesia in the median area, indicating the active but not yet complete regeneration of the median nerve. All the motions noted in the previous examination were of greater range and strength. The bony growth from the capitellum could be readily felt and the head of the radius came up against it with a click and stopped extension at a right angle. Mobilization of the elbow should be the next step.

After the first few months of treatment the outlook seemed nearly hopeless, but perseverance in treatment, stage by stage, has led to the improvement of the last few months which makes the prognosis most hopeful.

Courage for continued effort was given by the known presence of viable muscle at the upper ends of the flexor muscles near the

inner condyle, and the early evidences of beginning recovery in the ulnar and median nerves after operation in May, 1915.

For the results so far obtained too much credit cannot be given to the intelligent and absolute devotion of the trained nurse who has been in continuous charge of the case.

CASE IV.—Margaret D., eight years old. Toward the end of June, 1914, she broke both bones of the left forearm at the middle. After reduction wooden splints were used for two days and were then replaced by a circular plaster splint. Within a few hours there occurred severe pain, with swelling and cyanosis of the fingers and hand. She was awake and cried all night. On the second and third days the swelling and cyanosis were very marked and then gradually subsided.

On the seventh day the cast was removed. The fingers were then beginning to flex. There was a slough on the flexor surface a little below the elbow, and a deep ulcer in the hypothenar muscles, which was two months in healing. The contracture of the fingers became steadily worse.

September 21, 1914. The patient was a healthy, well nourished girl.

The left hand and forearm showed the typical well marked deformity. (Fig. 11.)

There was some bowing forward of both bones in the middle of the forearm and there was a hard mass between them. The wrist was markedly flexed, had no voluntary motion, and very slight passive motion. Attempts to extend the wrist flexed the fingers more tightly. The fingers had a very slight degree of active flexion. The skin was thin and shiny. The sensations of the hand and arm were normal except for hypæsthesia of the ulnar side of the little finger (perhaps resulting from damage to the ulnar filaments in the old abscess and scar of the hypothenar eminence). The elbow could be actively flexed and extended completely. Treatment was started September 25, 1914.

November 16, 1914 (8 weeks). The wrist was extended well backward of the straight line although the fingers flexed moderately at the same time. Active motion of the fingers was much improved and the interossei were beginning to act.

The flexor group in the upper forearm could be felt to contract actively but the resulting motion was slight because of some obstruction at the site of fracture.

The thumb did not move but remained close to the index finger. Sensation was still deficient on the ulnar edge of the hand and little finger.

During the spring of 1915 she died of what was said to have been tubercular meningitis before there had been further opportunity for her to come to town for examination.

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### SUMMARY

Experimental work and clinical observation point to *traumatic myositis* as the fundamental condition in causing Volkmann's ischæmic contracture.

The pressure causing the muscle disorganization is both internal and external: Internal, because the flexor muscles are firmly confined by their envelope of aponeurosis and bone, and, when injured, have no chance to expand to relieve the pressure due to extravasation and œdema. External, because of tight dressings or the position of acute flexion at the elbow.

The result of the pressure is to cause degeneration of the muscle substance and its replacement by connective tissue, the contraction of which causes the typical deformity.

The damage to the muscle may be very slight, it may be complete, or it may be of any grade between these two extremes, and it is impossible clinically to determine at an early time just how extensive the damage is. (See Case II.)

*Complications.*—Pressure sloughs and abscesses are common on the ulnar side of the wrist and on the flexor prominence just below the elbow. When present, these abscesses usually burrow to the deeper structures, heal very slowly and add greatly to the cicatricial rigidity.

Thomas<sup>27</sup> found these present in 37 out of 107 collected cases.

Nerve injury is purely a complication. It occurs in about 60 per cent. of cases. It may be *primary* as a result of the accident and may involve one or all of the nerves partially or completely. However, the ulnar and median nerves are the ones usually involved, the musculospiral escaping. It may be *secondary* and by far the larger portion of the 60 per cent. belong in this class. It may occur early, as the result of the pressure of the swollen muscles, or, more frequently, later as the result of cicatricial constriction. The ulnar and median nerves are most often involved and are usually constricted within a short distance below the elbow.

Interference with function is usually only partial, but it may be complete.

The usual clinical history is: Child of 1 to 14 years of age. Fracture in elbow region (general term for neighborhood) put up in tight dressing, or in extreme flexion of the elbow, and usually left untouched for from 4 to 10 days. Very soon, severe pain, swelling and cyanosis of the hand, often blebs, sometimes rise of temperature. The pain and swelling gradually subside and the rigid flexion contracture develops early or late according to the case. The deformity, once developed, is

characteristic. There is moderate pronation of the forearm, marked flexion of the wrist, extension of the metacarpo-phalangeal joints, marked flexion of the remaining finger joints. The thumb is often firmly adducted. There may be some active motion in the flexors but it is always very slight. Attempts to extend the wrist passively cause marked flexion of the fingers; full flexion of the wrist permits extension of the fingers. The flexor group of muscles and tendons stand out as a hard, firm, rigid mass, obviously the cause of the resistance to motion. The feeling of the mass and its resistance to motion do not indicate just how complete the cicatricial change is. (See Case II.) The hand is usually cold and blue from deficient circulation, and these symptoms are aggravated if there has been nerve damage. Nerve damage is indicated by partial or complete loss of sensation, by motor paralysis (which can usually be distinguished only in the intrinsic muscles of the hand since the flexor muscles in the forearm have lost their function from the myositis), and by trophic disturbances also most noticeable in the hand and fingers.

*Prognosis* should, as a rule, be unfavorable. Inasmuch as it is impossible to determine clinically the exact amount of damage, an accurate prognosis cannot be given until the reaction to proper treatment has been watched for a time.

*Treatment.—Prophylactic:* In children from 1 to 14 years, in injuries about the elbow region, tight dressings should be avoided, as well as extreme angle of flexion at elbow. In all injuries of this type, the medical attendant should be in constant touch, so that if undue pain, swelling and cyanosis occur, prompt measures may be taken to prevent the full development of the lesion.

*Immediate:* All dressings should be removed, the limb elevated, and gentle massage and passive motion given while the site of fracture is steadied and supported by hand. If in spite of these measures the swelling and cyanosis increase, one should attempt decompression of the flexor muscles by splitting the deep aponeurosis longitudinally, either subcutaneously, or together with the skin if that is œdematous and shiny. Sterile dressings and a light supporting splint with the elbow at right angle (or more) should be applied.

When the danger of the ischæmic lesion is passed the fracture may be treated as best the circumstances permit.

*Late:* Operation either lengthens all the tendons of the contracted muscles to permit simultaneous extension of the fingers, hand and wrist to a straight line, or shortens the bones sufficiently to attain the same result. The risks of operation are increased by the poorly nourished

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condition of the extremity, and the growth of the bones will gradually cause recurrence of the deformity (see Case I). Lengthening the tendon of a muscle lessens its efficiency.

After an operation has mechanically relieved the deformity, the real work of rehabilitation must be done by a prolonged course of physical therapeutics. Therefore it would seem preferable to avoid the trouble and risk of operation by employing the method of mechanical overstretching of the contracted tissues. This method combined with physical therapeutics, obtains results which for promptness and quality are as good or better than those obtained by operation.

This may be accomplished by the Jones method of rigid splints, or by the method preferred by the author which may be called the elastic traction method.

Cases may make a full recovery in a few weeks (Case II) or may require months or years before the best result is obtained (Case III). Nerve injuries cannot be operated upon during the acute stage of the myositis.

If nerve has been injured primarily at the accident (and this is difficult to determine as a rule) exploration and repair should be done shortly after the subsidence of the acute stage.

When the symptoms of any nerve damage persist after the deformity has been overcome by stretching, exploration should be made, and appropriate treatment carried out. Usually the compression is just below the elbow, so that exploration should first be done there and carried upward or downward as conditions indicate. Where there has been fracture of the inner condyle the ulnar nerve should be explored behind it, if there are symptoms of interference with ulnar nerve function. (See Case III.)

Finally, persistence in treatment is the one hope of success in the severe cases.

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# GUNSHOT INJURIES OF THE PERIPHERAL NERVES AND THEIR TREATMENT\*

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ON account of the far-reaching consequences to the patient the treatment of injuries of the peripheral nerves has always been an important problem to the surgeon.

In peace times the experience of the individual surgeon has been very limited for obvious reasons. During the first two years of the great European War, the number of nerve injuries has been appalling and the treatment of nerve wounds constitutes one of the most urgent problems facing the surgeons of the belligerent nations.

During my work in Germany as chief surgeon of a Reserve Lazaret in Oppeln in lower Silesia, from October, 1915, to April, 1916, there were among 365 cases of wounds of the upper and lower extremities, 15 cases of paralysis of one or more of the peripheral nerves. Of this number 8 patients improved so much under massage and electrical treatment that surgical interference was deemed unnecessary. In 7 cases operative interference was indicated.

CASE I.—E. P. was wounded on November 12, 1915, by a rifle bullet in the right thigh. Wound of entrance 10 cm. above the external condyle of the femur; wound of exit 8 cm. above internal condyle. Both wounds were healed. There was a complete paralysis of all the flexor and extensor muscles of the leg.

The patient was treated by massage and electricity without any result for eight weeks.

*Operation* (February 2, 1916).—The sciatic nerve was isolated and it was found that 3 cm. below its bifurcation the peroneal nerve was deeply imbedded in a dense scar tissue. After removing this by careful dissection, the peroneal nerve presented a spindle-shaped scar 2 cm. in length. This scar was excised and the nerve stumps carefully sutured with four fine silk sutures which only passed through the perineurium. The suture was surrounded by a cuff of fat tissue and the skin wound closed.

CASE II.—I. G., wounded near Dünaburg on September 9, 1915, by a rifle bullet which penetrated the upper arm just below the anterior axillary fold. When he entered the hospital his

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## GUNSHOT INJURIES OF PERIPHERAL NERVES

wound had healed but he showed all the symptoms of a complete median and ulnar nerve paralysis.

As the wound was received about three months before and there was no sign of improvement, operation was decided upon. Both nerves were found completely severed and their stumps imbedded in dense scar tissue. The median nerve showed a large neuroma at the proximal stump.

After excision of the scar there was a defect of  $2\frac{1}{2}$  cm. in the median and a defect of  $2\frac{3}{4}$  cm. in the ulnar. The stumps could, however, be approximated without much trouble by 4 sutures through the perineurium. Both sutures were covered by a cuff of fascia, taken from the fascia lata of the thigh.

CASE III.—T. D., wounded on August 17, 1915, by a rifle bullet in right shoulder. The wound had healed. Right after receiving the wound, his entire right arm was paralyzed.

Examination showed injury involving median, ulnar and radial nerve.

Dissection of nerve just below margin of pectoralis major revealed all three nerves imbedded in a large and dense mass of cicatricial tissue and completely severed.

The isolation of the different nerve trunks was very tedious and difficult. The proximal stumps of the median and ulnar nerves each showed a large neuroma. The scar tissue was incised and the nerve stumps sutured. Although there was a defect of 6 cm. in the median and a defect of 3 cm. in the ulnar and radial, suture was accomplished by approximation of the arm to the thorax. Each nerve suture was surrounded by a cuff of transplanted fascia lata.

CASE IV.—W. N., wounded near Brest-Litovsk on August 22, 1915, by rifle bullet in upper arm. Paralysis of ulnar and median nerve.

*Operation* (October 29, 1915).—Incision along inner border of biceps. Ulnar and median nerves were imbedded in cicatricial tissue almost as hard as cartilage. Both nerves were completely severed in the middle of the arm, the bullet having passed from above inward to below outward. The proximal end of the ulnar nerve showed a distinct large neuroma whereas the median nerve was more or less flattened at its proximal end.

Dissection was difficult, the brachial artery being firmly adherent to the median nerve posteriorly. After excision of the nerve-scar the diastasis between the proximal and distal nerve stumps exceeded 5 cm. A neuroplasty was done by deflecting a flap of nerve-tissue from above downward and suturing it to the distal stumps. In order to separate the nerves from extensive scar tissue in the underlying muscles which could not be removed, a large

flap from the fascia of the brachialis anticus was deflected and sewn to the muscular scar tissue below the nerves.

The belly of the biceps was carefully sewn over the nerves and the skin incision closed.

CASE V.—S. K., wounded on September 9, 1915, by shrapnel in left thigh. Wound of entrance posteriorly in lower third of left thigh, wound of exit on inner side of femur a little further down. Peroneal paralysis.

*Operation* (November 11, 1915).—On exposing the sciatic nerve it was found that the same had been button-holed by the bullet just above its bifurcation. The nerve fibres of the tibial were fairly intact but the fibres of the peroneal were covered and bound together by scar tissue. A neurolysis after Stoffel was done which was not very difficult to accomplish, and the individual fibres of the nerves were thus freed from scar tissue.

CASE VI.—A. J., wounded near Brest-Litovsk, August 29, 1915, by rifle bullet 2 cm. below the knee-joint near the head of the fibula. Peroneal paralysis.

*Operation* (November 3, 1915).—The peroneal was severed just 1 cm. above its division into its muscular branches.

In this case an autoplasty was tried as it was evident that the nerve stump after excision of the scar could not be reunited. For this purpose the proximal stump of the peroneus was split, one-half cut off and implanted between the stumps. One-half of the distal end of the transplant was united with the distal end of the external peroneal, and the other half with the deep peroneal. A flap of fascia from the soleus muscle was deflected anteriorly and sewn over the graft. The wound was closed.

Unfortunately an infection occurred and the skin wound had to be opened and drained.

CASE VII.—A. Y. fell during the winter battle in the Carpathians in 1914 and injured both legs, a munition wagon passing over him. A splint was applied in a field hospital. When this was removed later on, he showed a peroneal paralysis of both legs. The X-ray pictures of this case were interesting as they showed a large osteoma that had developed in the biceps-tendons of each leg. It was thought possible that these bony masses might have been responsible for the paralysis of the nerve through pressure.

Operation showed that both nerves were almost completely destroyed for a distance of about 4 cm. on the right and 5 cm. on the left side, a thin thread of tissue only being left which connected the proximal and the distal stumps. These were reunited by a nerve plastic.

## GUNSHOT INJURIES OF PERIPHERAL NERVES

The operations performed in our seven cases were, to sum up: In three cases nerve suture; in two neuroplasty; in one neurolysis after Stoffel; in one auto-grafting. Unfortunately, I am not able to report on any end-results.

When I left Germany the cases had been operated upon only a short while before and none of them had shown any symptoms of returning sensation or muscular power. Nevertheless, I thought it might interest you to hear how German surgeons try to solve the question of curing paralysis of the peripheral nerves, and for this reason allow me to speak to you about the work that is being done in Germany along these lines and the results that have been achieved so far.

*Types of Injuries.*—Gunshot injuries of the peripheral nerves show a very varied picture. The direction in which the bullet is fired and the position of the limb at the moment of impact will, in a large measure, determine the amount of destruction. Those cases in which the bullet struck the nerve at an acute angle to its long axis, show the greatest amount of destruction of nerve substance as our fourth case showed. In other cases only individual fibres are destroyed when the bullet grazes the nerve.

In the present war perforation of a large nerve is not rare, on account of the small caliber of the modern army rifle and the velocity of the bullet (Case V), the bullet in these injuries apparently pushing the individual fibres apart. In a certain number of cases the nerve itself is not injured at all by the bullet, but simply contused, directly or indirectly, by the passage of the ball through the tissues. Particles from shells or bullets or spiculæ of bone, often smaller than a millet seed, may become imbedded in the substance of the nerve, causing, besides the palsy, unbearable neuritic pain. A scar that develops after a wound may produce a secondary paralysis by pressure, the nerve having escaped the bullet.

The nerves most frequently affected are the radial and the ulnar, then follow in order of frequency the median, the peroneal, the sciatic and the brachial plexus.

*Diagnosis.*—The diagnosis of a nerve injury is generally not very difficult. There are, however, cases in which injuries of the extremities are associated with paralysis of the affected limb, in which an actual nerve injury has not taken place. I refer to those cases, where the shock of the injury has induced a functional paralysis of a part or a whole limb. Hysterical phenomena may also appear in the form of contractures or hyperæsthesias, or hemiplegia. To distinguish between these conditions it is necessary to remember that hysterical paræsthesia or anæsthesia will never follow the anatomical distribution of a peripheral

nerve, and in hysterical anæsthesia the skin is moist and sweaty, while in severe nerve injuries the skin is cold, dry and scaly. The presence or absence of reflexes is also of great importance. They are absent in true paralysis due to nerve injuries. Generally speaking the functional paralysis can be differentiated with little difficulty, if the patients are properly observed and neurologically examined.

The diagnosis of the actual injury which a nerve has sustained, however, is very difficult and in a fair number of cases impossible. With all our known methods of neurological examination we are unable to differentiate between a contusion, a partial severing or a complete break in the continuity of a nerve trunk, for we are apt to obtain a reaction of degeneration in all three conditions. This uncertainty in the diagnosis has been the causative factor of the discrepancy of opinion among neurologists and among surgeons as to the indication of operative interference, and especially as to the time when conservative treatment should be abandoned and an operation advised.

Foerster, of Breslau, with whom I had the opportunity to discuss this question in relation to my own material, is conservative as to time. He advocates operation if after 4 to 6 months no improvement has shown itself and the galvanic reaction grows weaker. Spitzzy, Wilms and other surgeons advocate early operation for the reason that the diagnosis of the extent of the actual nerve injury is so very uncertain, and because the operation itself is practically without danger.

In fresh cases, where on account of the nature and the seat of the injury a complete division of a nerve is suspected and where there is no infection, a primary suture will always give the best results. If there is doubt as to a complete separation of the nerve, we may wait for a few weeks.

If, however, on electrical examination, the galvanic reaction becomes weaker and slower, the nerve should be laid bare and inspected. Cases in which the injury dates back longer than 2 to 4 months ought to be operated upon, also those cases in which only a slight improvement has taken place. This is especially imperative since it is known that such excellent results are achieved after Stoffel's method of neurolysis in intraneural scar tissue. There are cases on record where, after the excision of intraneural scar tissue, with freeing of the individual nerve fibres from pressure, the nerve function has returned after a few hours. I will touch upon this point later on in detail.

Before I proceed to discuss the different operative procedures I will dwell upon the histology of nerve repair, the study of which,

## GUNSHOT INJURIES OF PERIPHERAL NERVES

especially in the last ten years, has guided the surgeon, and has put the treatment of nerve wounds on a more rational basis.

Through the study of Edinger, Buendner, Bethe, Cajal, Ranvier, and Doinikow, we know that restitution of the nerve is possible only when the central end can send out new fibres to meet the peripheral stump.

When a nerve has been severed it will be seen that after a very few hours, the divided axis cylinder will pour out a peculiar fluid substance in the form of droplets. In their endeavor to reach the peripheral end they grow out into fine threads which immediately meet the resistance of coagulated blood and young connective-tissue cells, interposed between the divided ends. As soon as these fine threads meet with this resistance they are deflected from their course towards the periphery and bend back towards the brain or deviate laterally, producing well-known and characteristic pictures. By this process the familiar end neuroma is formed (Figs. 1 and 2).

This irregular and seemingly aimless protrusion of threads will stop immediately, as soon as some fibres of the interrupted nerve-tract are encountered. With the help of the cells of Schwann the degenerated peripheral nerve trunk is comparatively quickly neurolized by the new fibres growing into it from the central stump. New marrow-sheaths are formed and the nerve is completely regenerated.

To sum up: *The central ganglia cells push out new nerve fibres as long as there is no resistance. Resistance (i.e., scar tissue) deflects the new nerve fibres. The nerve is regenerated by those fibres which reach the cells of Schwann, left over in the peripheral degenerated nerve.* From these histological facts two operative indications are deduced.

1. To remove the resistance as thoroughly as possible.
2. To pave the way for the new fibres to reach the peripheral stump (Edinger).

*Methods of Operation.*—In fresh, uninfected wounds of the extremities with injuries of nerves, the suture of the stumps is the procedure of choice. The nerve stumps must be very carefully handled with small pointed forceps, and care should be taken to grasp the perineurium only. The nerve stumps must not be rotated around their long axis in order to reunite the stumps of the individual fibres. Three to four sutures are sufficient. The suture material may be finest silk or catgut. Some surgeons warn against silk on account of the danger of an intraneural scar formation, to which silk is apt to give rise more frequently than catgut. On the other hand, catgut is not as firm and is quickly absorbed. As the suture should only be put through the

perineurium, without entering the nerve substance proper, I think this danger of scar formation is overrated.

Under the present condition of warfare the cases can rarely be operated upon immediately. The surgeon will always be confronted by cases in which more or less extra and intraneural scar tissue is present. In these all cicatricial tissue should be carefully excised. The end neuroma has to be removed until normal nerve fibres are seen on the cross-section of the nerve. Defects of 2 to 2½ cm. can usually be overcome. If the defects are larger and the nerve defect is near a joint, flexion of the limb will help approximation of the stumps.

In cases in which there is no complete division of the nerve there is found a spindle-shaped swelling of varying extent of the nerve itself. Here it is sometimes difficult to determine whether the nerve fibres are entirely or only partially destroyed. This spindle-shaped thickening is the so-called intraneural scar. It occurs in nerves that have been contused and pressed upon by a bullet or a splinter of bone. The perineurium of the nerve is injured, causing a hemorrhage around the nerve. In the substance of the nerve itself individual fibres may be torn and there also occur hemorrhages in the intraneural connective tissue. *This intraneural scar tissue envelops the individual nerve fibres and compresses them.*

In such cases the removal of the scar tissue around the nerve is not sufficient. Here an intraneural neurolysis (Stoffel, Heile, Hezel) is necessary to re-establish conductivity.

In order to remove the perineural scar the normal perineurium, proximally and distally from the scar, is carefully incised and lifted from the nerve with fine forceps. This enables one to get into the right plane of tissue. The incision is now carried into the scar and by blunt dissection the cicatrix is removed. This procedure is usually simple. The excision of the intraneural scar is a little more difficult. It is best to start again a little beyond the thickening of the nerve and, with a fine knife isolate a nerve fibre and follow it through the scar, completely freeing it from adherent tissue. The rest of the nerve fibres have to be treated in the same fashion, so that at the end of the operation the nerve is split up in its component "cables" (Figs. 3-7).

According to Stoffel, intraneural scars of 2 to 4 cm. length can thus be removed with comparative ease. When, however, the indurated tissue measures 6 to 8 cm., the tracing of the individual fibres is sometimes impossible. Fortunately these cases are rare.

Heile has recommended injections of sodium chloride solution into the intraneural scar, thereby facilitating the isolation of the individual

fibres. Von Hofmeister uses novocaine-adrenalin solution for the same purpose.

A thorough and special knowledge of the topography of the nerves is essential to good results. Most important are those fibres which convey motor-impulses and these should be freed as thoroughly as possible.

For instance, if we have to deal with a scar in the peroneal nerve, Stoffel recommends to first free the fibres leading to the tibialis anticus muscle. These are situated laterally and run close to the biceps muscle. After that the fibres of the extensor digitorum longus and hallucis longus and further on the fibres of the peroneal muscles are freed, this last bundle lying in the dorso-mesial aspect of the nerve.

In the median nerve we have to be especially careful to free the scar from its posterior surface, because here lie the most important motor fibres.

For want of space I cannot here describe the inner topography of the nerves. Those who are interested in this topic are referred to the publications of Stoffel.

After all fibres have been freed the nerve is ensheathed. Stoffel uses for this purpose calf arteries prepared after Foramitti.

The results which have been obtained by this endo-neurolysis have been surprisingly quick and good. Stoffel, Lange and Trumpp report that after neurolysis complete restitution can occur in two to three months.

It is, therefore, advisable never to resect an intraneural scar, before one has made sure by neurolysis, whether the fibres are really completely divided. Sometimes only certain fibres are divided whereas others have escaped. In such cases resection and neurolysis should be combined.

After the resection of the scar tissue, the defect in the nerve may be so large that suture of the stumps is impossible. Under such conditions other methods must be used. These are: (1) *Tubulization*; (2) *neuroplasty*; (3) *nerve-grafting*.

*Tubulization*.—Vanlair was the first to suggest that nerves might regenerate, if a path was provided along which the new fibres developing from the central stump might pass to reach the distal part. He, therefore, suggested placing the nerve stumps in tubes. Kirk and Lewis have recommended forming these tubes from fascia which is accomplished by free transplantation. Experiences, however, have shown that new nerve fibres do not grow into empty spaces and the fascia tubules are liable to contract and form scar tissue.



Harrison and Edinger proved that from pieces of spinal cord immersed into serum or into agar, new nerve fibres grow out into the medium. This can be seen and demonstrated under the microscope.

After a series of experiments Edinger finally worked out a practical method. He filled calves' arteries of different length with agar and had them sterilized. Ludloff was the first to use them in his nerve operations. They are now manufactured wholesale by large firms in Germany which also take the responsibility for their absolute sterility. These prepared arteries are enclosed in hermetically sealed glass tubes. The ends of the artery are closed by a ligature in order to prevent the agar from leaking out. Before use they are sterilized once more for 15 minutes, the tubes are then allowed to cool off, because the agar must be in a semi-solid state.

The scar in the nerve is excised in such a fashion that a few millimetres of scar tissue are left on both stumps. A thread is tied around this end *still inside the scar tissue* and with a needle pushed through the wall of the artery far enough from its end to enable one to pull the stump of the nerve into the agar-filled artery. The nerve is now fixed by a perineural suture to the end of the artery. The artery is then incised, at the site of the thread, and the nerve pulled out, the scar tissue cut off with a sharp knife and the nerve dropped back into the arterial tube, without handling the freshened stump. The little incision in the wall of the artery is closed by a suture. One has to endeavor, of course, to bring the ends of the nerves as closely together as possible.

Ludloff and Hasslauer had operated upon 14 cases up to February 15, 1916, by this method. Defects of 5 cm. to 20 cm. had been bridged. In all these cases, after 2 to 3 weeks, certain phenomena of regeneration showed themselves. The areas of anæsthesia became smaller and in a case where 10 cm. of the tibial nerve and 8 cm. of the popliteal nerve had been removed some muscular movement and the plantar reflexes returned sixteen days after the operation.

The improvement continues for some more weeks, but then follows a period of slow progress, this is obviously caused by the slower recuperation of muscles and joints.

Six to seven months after the operation there are still found on examination some difference in the volume of the muscles and some disturbance of sensation.

The Edinger method has been tried by numerous surgeons who also reported satisfactory results. There are undoubtedly some advantages of this method over the old suture and also over the newer methods of neuroplasty and grafting. When I left Germany the method had gained favor with many surgeons, but unfortunately I cannot supply

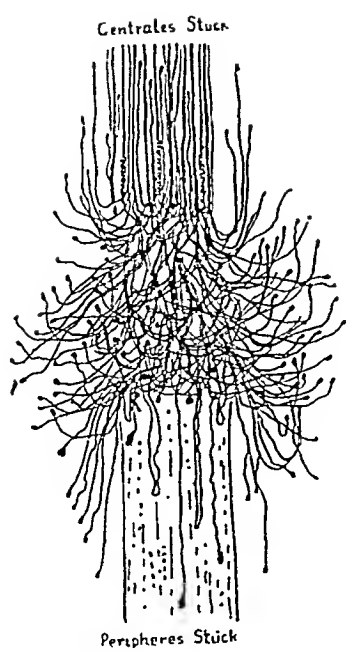


FIG. 1.—After Cajal.

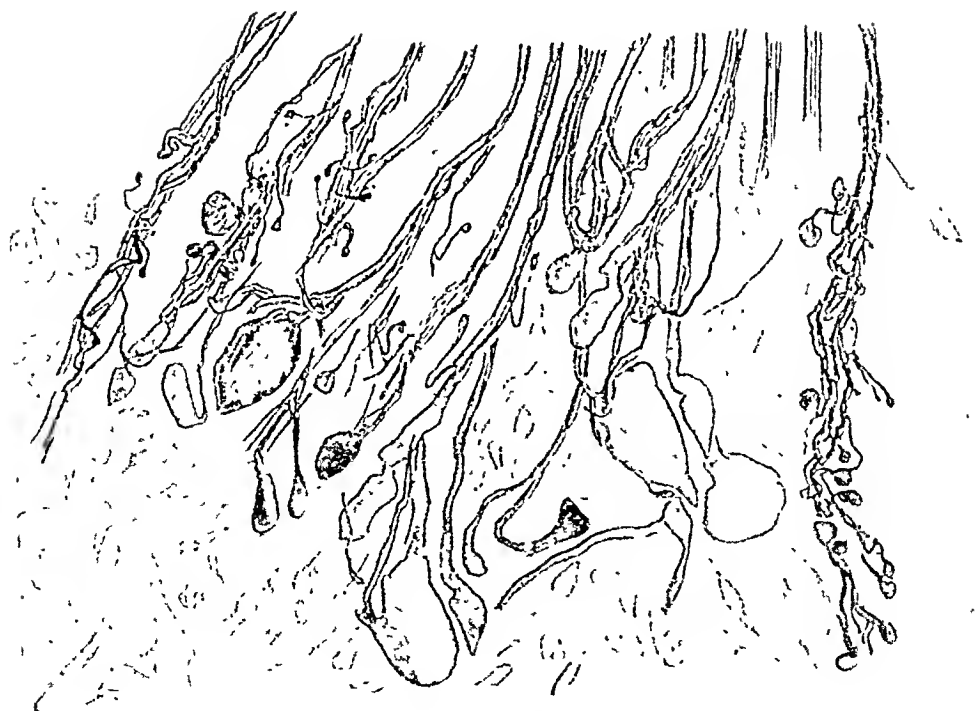


FIG. 2.—After Cajal.

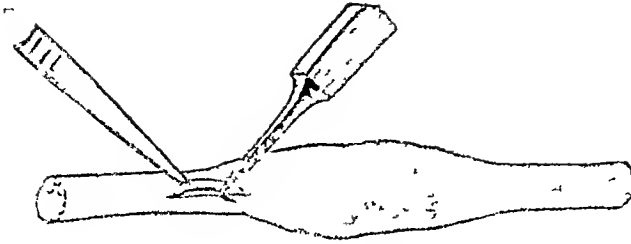


FIG 3.—After Stoffel

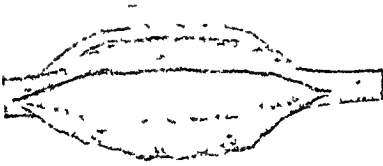


FIG 4 —After Stoffel

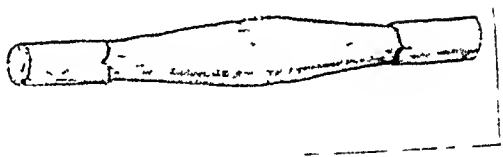


FIG 5 —After Stoffel.

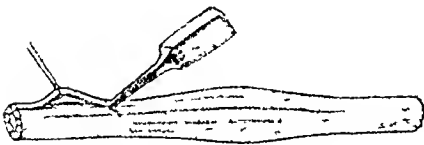


FIG 6 —After Stoffel.

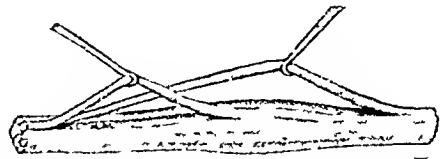


FIG. 7.—After Stoffel.

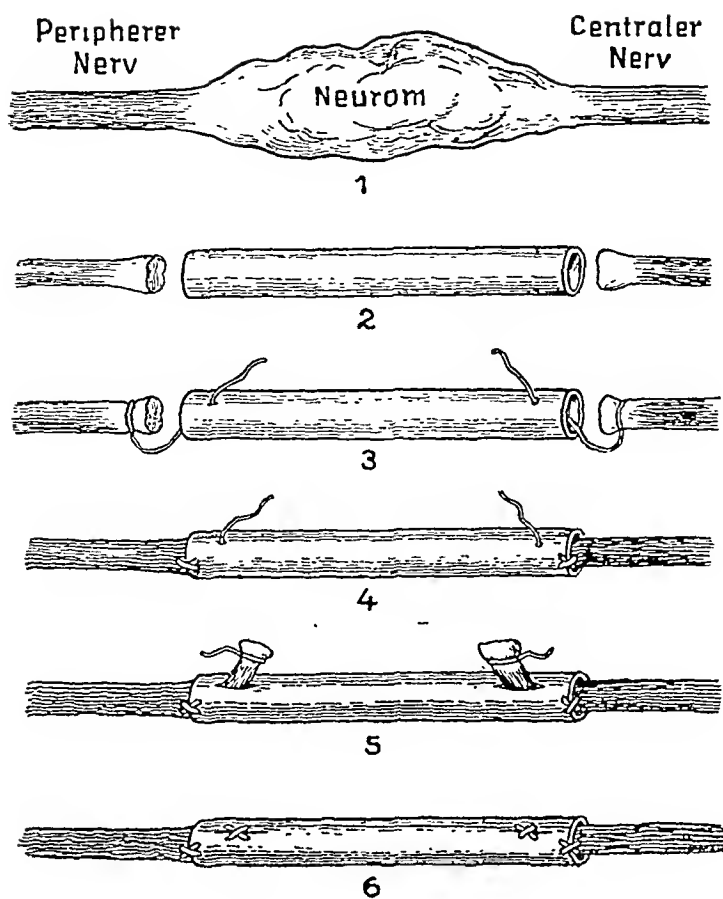


FIG. 8.—After Ludloff.

	Resektionen	Neurolysen	Tubulisation
<i>Plexus brach.</i>	Besserung 5 (100%) Ohne Erfolg Entlassen	5 2 6 (100%)	8
<i>Radialis</i>	Besserung 12 (60%) Ohne Erfolg 8 (40%) Entlassen 5	25 2 5 (100%)	7 1 (20%) 4 (80%)
<i>Medianus</i>	Besserung 4 (33%) Ohne Erfolg 8 (66%) Entlassen 1	13 2 (150%) 2 (150%)	7 2 (100%)
<i>Ulnaris</i>	Besserung 3 (30%) Ohne Erfolg 7 (70%) Entlassen 3	13 1 (33%) 2 (67%)	3 1 (14%) 6 (86%)
<i>Ischiadikus</i>	Besserung 2 (40%) Ohne Erfolg 3 (60%) Entlassen 7	12 1 (33%) 2 (67%)	3
<i>Tibialis</i>	Besserung 1 (33%) Ohne Erfolg 2 (67%) Entlassen 1	4 6 (100%)	6
<i>Peroneus</i>	Besserung 1 (11%) Ohne Erfolg 13 (89%) Entlassen 7	21 4 (100%)	4

FIG. 9.

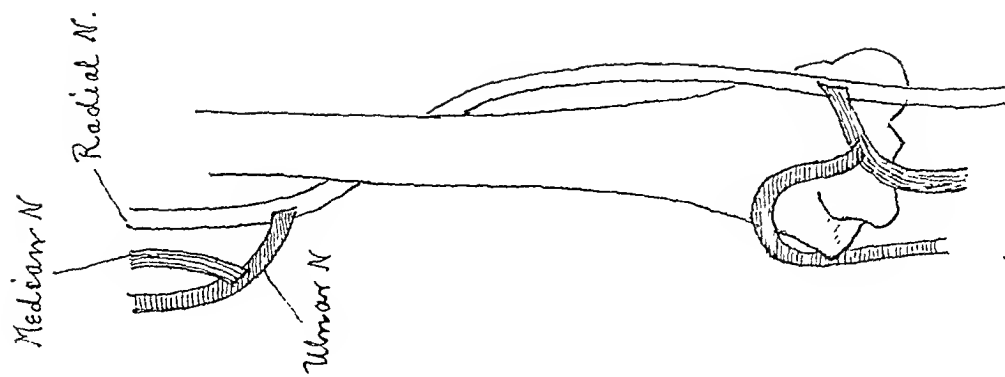


Fig. 13.

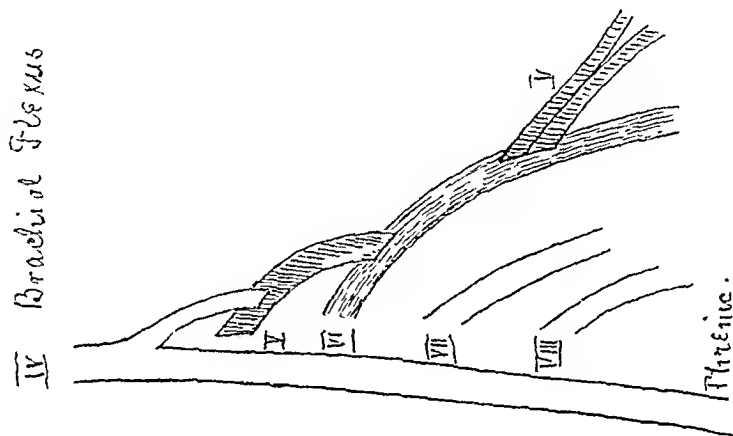


Fig. 12.

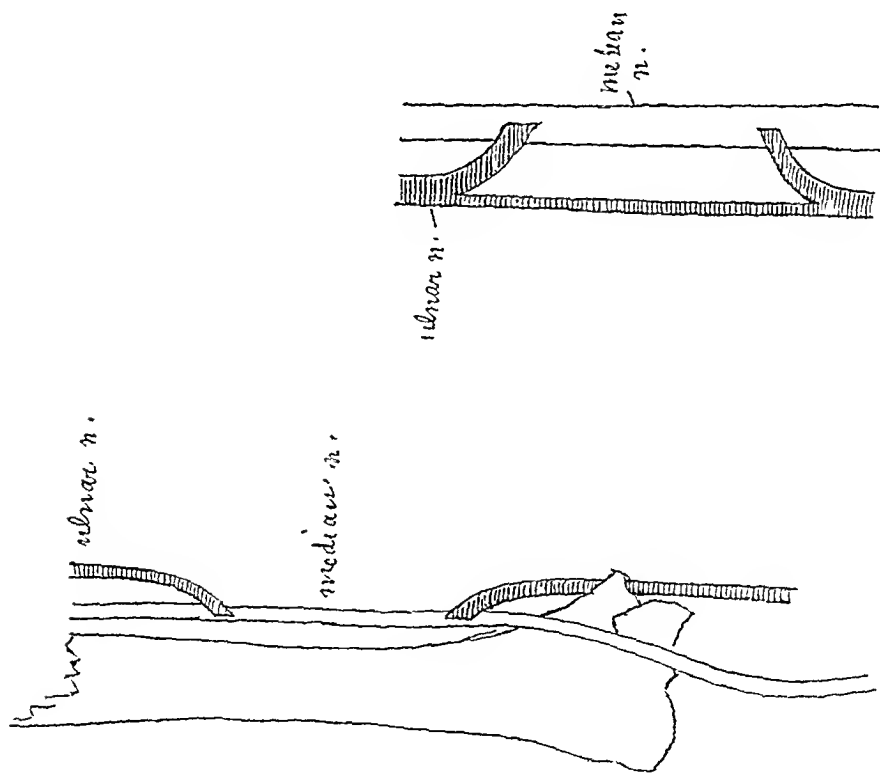


Fig. 11.

Fig. 10.

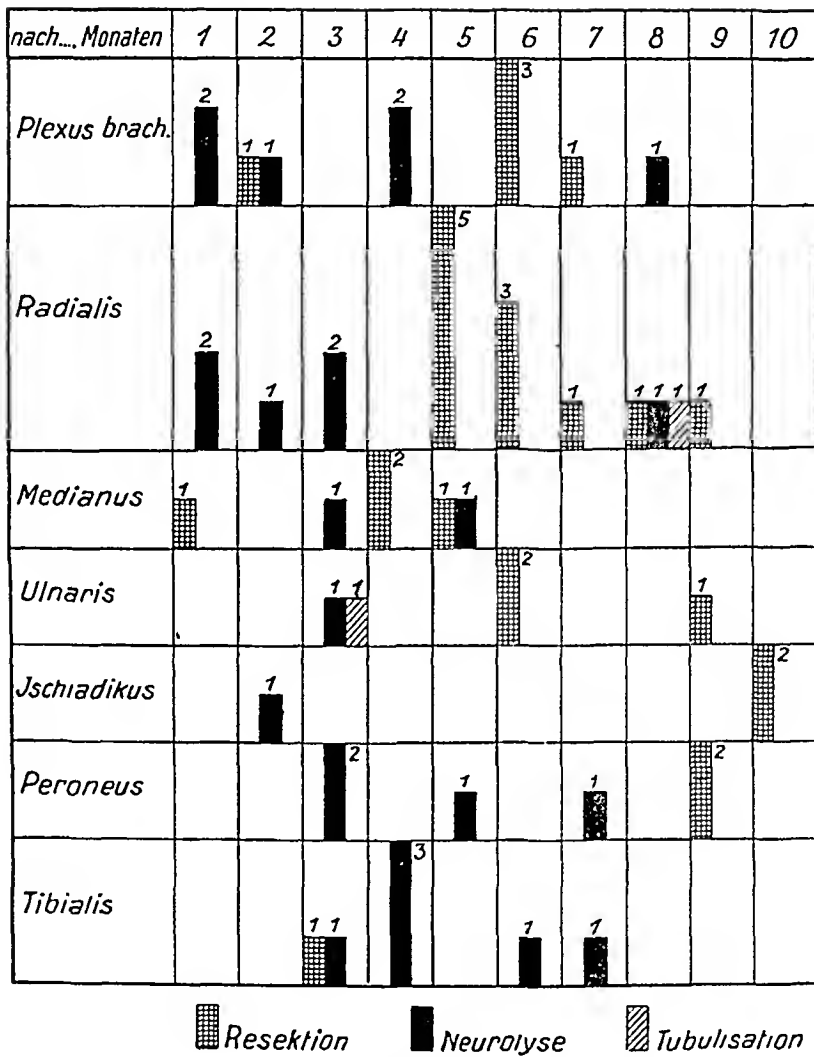


FIG. 14.



information of later results, as no medical literature from Germany reaches us at present.

A few words as to the best tissues with which to envelop the site of the nerve suture in order to avoid a new perineural scar. The material used most is calves' arteries prepared with formalin after Foramitti and fat. Of late many surgeons have objected to the use of fascia because, although it heals in almost all cases, yet it has the tendency to shrink and be changed into scar tissue.

*Neuroplasty.*—The bridging of large nerve defects has also been tried by nerve plastic. This is done by bringing down a lateral flap from the central stump after the well-known method of tendon-lengthening.

In one of my cases (Case VI) a free graft was taken from the central stump and the defect thus remedied. On the whole neuroplasty after this method has found little favor with surgeons and some consider it useless.

A new idea of nerve-grafting has been proposed by Von Hofmeister. He implants the central stump of the resected nerve into a normal nerve running parallel to it, and the distal stump a little further down into the same nerve, thus using the normal nerve as a bridge. He has used double grafting and multiple graftings in injury of the brachial plexus. A motor nerve, or a sensory nerve, or even a degenerated and paralyzed nerve, as long as it shows no scars, can be used as a bridge. Individual fibres of a nerve which have been injured can also be implanted into those fibres of the same nerve that are still intact.

This method can be used with special advantage on the brachial plexus and the nerves of the arm (Figs. 10 and 13).

Thick nerves like the median and sciatic are well adapted for the grafting of single fibres.

Von Hofmeister reports 24 cases in which this method has been tried with encouraging results, although the time is yet too short to judge the method by definite cures.

*Prognosis and Results.*—Although German surgeons up to date have been very conservative in judging their results by the different operations in nerve injuries, there are, however, a very large number of complete cures reported by them.

The average time after which a complete cure can be expected fluctuates between six months to one and one-half years.

I have appended the original statistics of Spitzzy which were published in March, 1916, and which show the results of his operations, and also give the length of time which elapsed until motility of the paralyzed muscles was re-established (Fig. 14).



## CARCINOMA OF THE BREAST\*

BY JOHN CHADWICK OLIVER, M.D.

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I HAVE chosen this subject for three reasons. First, because the condition is relatively common. Second, because the diagnosis is comparatively easy, and third, because the treatment, once the diagnosis is established, has been definitely determined.

The stomach, uterus and the breast are the most frequent sites of carcinoma. This disease occurs about twice as frequently in the stomach as in the uterus, and is about twice as frequent in the uterus as it is in the breast.

*Statistics.*—The statistics taken from the Cincinnati Hospital, extending over the period from 1865 to the present time, show the proportion given above to be fairly accurate.

Statistics taken from the Health Department, which, of course, only records deaths, show about the same condition of affairs.

No doubt each one of us has been impressed by the oft-repeated assertion that cancer is a disease showing a marked tendency to increase in frequency, but we may have accepted this statement without any investigation as to whether the facts bear it out or not.

Having a desire to see what the actual figures are, I have investigated the reports from the census of the United States, statistics for New York City, and also for Cincinnati. My figures from the former sources are necessarily taken from reports appearing in journals, but the Cincinnati statistics have been obtained from a study of the death returns in the Department of Health.

The report in the United States is as follows: "Cancer and other malignant tumors filled 52,420 graves in 1914. Of these, 19,889, or almost 38 per cent., resulted from cancer of the stomach and liver. The death rate from cancer has risen from 63 per 100,000 in 1900 to 79.4 in 1914. This increase has been almost continuous, there having been but two years, 1906 and 1911, which showed a decline as compared with the years immediately preceding. It is possible that at least a part of this indicated increase is due to more accurate diagnosis and greater care on the part of physicians in making reports to registration officials" (*Science*, April 21, 1916, p. 563).

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\* Read before the Cincinnati Academy of Medicine, October 9, 1916.

## CARCINOMA OF THE BREAST

Frederick L. Hoffman has an article on "The Cancer Mortality of Greater New York," in the *New York Medical Journal* for December 30, 1913, in which he says: "The probable number of deaths from cancer in the United States during 1913 will be about 75,000. Of this number, approximately 30,000 will be deaths from cancer of the stomach and liver; 12,000 from cancer of the uterus and other female organs of generation; 10,000 from cancer of the peritoneum, intestines, and rectum; 7000 from cancer of the breast, and the remainder, cancer of other organs and parts. In the State of New York, during the year 1912, there were 8234 deaths from cancer, equivalent to a rate of 86 per 100,000 of population, which is above the average for the United States at large. The number of cancer deaths in Greater New York, in 1912, was 4071, and the corresponding cancer death rate of 80.9 per 100,000 of population was the highest on record for the city since the records have been kept. The average cancer death rate of Greater New York for the last five years has been 77 per 100,000 of population, which compares with 94 for London, 109 for Paris, and 107 for Berlin. The corresponding rate for Chicago was 78; for Philadelphia 86, and for Boston 107. In 1912 the cancer death rate of Greater New York was 66 for males, and 96 per 100,000 of population for females. The excess in the mortality of females is almost entirely due to cancer of the uterus and cancer of the breast.

"The cancer death rate of Greater New York has increased during the last twenty years from 59 to 81 per 100,000 of population. The male cancer death rate of Greater New York has increased forty-three per cent., and the female rate during the same period has increased thirty-three per cent. In the old city of New York, or the boroughs of Manhattan and the Bronx, the cancer death rate during the last fifty years has increased from 24 to 86 per 100,000 of population, or at the rate of 253 per cent. during the intervening period. Cancer has increased in Greater New York at all ages, but the increase has been most marked at the ages of fifty-five years and over. The rate at this period of life has increased thirty-one per cent. during the last five years, when compared with the average rate during the previous five years. The rate has increased in all of the boroughs, but not to the same degree, partly on account of the influence of the hospital mortality, since the deaths in institutions are not redistributed according to the residence of the deceased. There has been an increase in the mortality from cancer of all organs and parts, except cancer of the skin, which shows a slight decrease for the last five years compared with the previous five years.

"As far as it is possible to judge, the Jewish and Italian populations are subject to at least average cancer death rates. There are no very trustworthy recent statistics for Greater New York, but the available data for Hungary and the city of Vienna sustain the conclusion that cancer among the Jewish population is of a relatively high degree of frequency. Since a rather large proportion of the Jews in Greater New York are of recent foreign origin, and as such a somewhat select class and mostly of the age period at which cancer is not common, it is readily apparent why, in medical and surgical practice, cancer cases among Jews in Greater New York should not be as frequent as might otherwise be the case. According to the statistics of the board of health for the last two years, the proportionate mortality from cancer among persons of Russian and Italian parentage has been relatively high, so that the foregoing conclusion is sustained by the only available data at the present time."

The statistics for Cincinnati, compiled from 1868 to 1916, show an increase in the number of deaths from cancer, from 36 in 1868 to 396 in 1915. If we figure the death rate in the years in which official censuses were taken, we find that in 1870 there were 42 deaths—population 216,239 persons—about one death to every 5148. In 1880 the population had risen to 255,139 and the deaths from cancer had increased to 105—one death in every 2429 alive at that time. In 1890—population 296,908—deaths from cancer 121—rate one in 2453. 1900, population 325,902, deaths from cancer 121, one in 2693. 1910, population 363,591, deaths from cancer 302, one in 1203. 1915, population (estimated) 406,706, deaths from cancer 396, one in 1027.

In this period of forty-five years the increase in deaths from cancer has risen from one in 5148 to one in 1027. This means that the ratio of deaths from cancer is five times what it was in 1870.

There can be no reasonable doubt in the minds of any one that part of the apparent increase in cancer can be explained by the greater accuracy of diagnosis at the present time, and also by the supposition that some fatal cases of ulcer of the stomach and duodenum are incorrectly ascribed to cancer, but even after eliminating these factors, we must still acknowledge both a relative and absolute increase in the incidence of cancer, and any amount of reasoning cannot explain away the grewsome fact.

*Need of Early Diagnosis.*—If this awful toll of human life can be checked by early and radical removal of the area involved, we may expect some diminution in mortality in the cases where the uterus or breast is involved, but, because of the difficulty in diagnosis and the

## CARCINOMA OF THE BREAST

inaccessibility of the stomach, one may be excused for being somewhat pessimistic regarding any considerable reduction in the mortality of cancer of the stomach.

Cancer of the breast should be more amenable to cure than when any of the other organs are affected, because its external position and the accessibility of the part for removal, with an unlimited amount of surrounding tissue, offer us the best opportunity for radical treatment. It would seem, therefore, that early removal of a cancerous breast should be followed by a very good percentage of cures.

If the dictum that cancer is always primarily a local disease, is accepted as a general proposition, subject to some exceptions, it may be stated very positively that the prospect of cure is greatest in the cases in which an early diagnosis is made. The later the diagnosis, the larger the death rate.

The safest definition of "early" is that the growth is small, single and circumscribed with no palpable involvement of the neighboring lymph tracts.

If we are to accept the dictum of the ordinary text-books, these symptoms are not sufficient to make a diagnosis of carcinoma of the breast, but on the other hand, if we wait for the symptoms set forth in text-books, we will have allowed the patient to pass over the period in which she may reasonably expect a cure. I believe, therefore, that except in the case of very young women, a lump in the breast is all that is essential in the making of a diagnosis of carcinoma.

I know that I will be open to the charge of being radical in making this statement as broad as I have, but I feel confident that the lives of a large number of women will be saved by acting on this assumption.

A fibro-adenoma of the breast is for all practical purposes a carcinoma in the making, and should be treated radically. Enucleation if possible. Amputation if necessary.

Time and again I have had the opportunity of observing a recurrent carcinoma in an area from which a fibro-adenoma had been removed sometime previously. In one case, that of a nurse, I removed a small adenoma from her breast, and fifteen years later made a radical operation for carcinoma beginning in the scar left by the previous operation.

In quite a few of my cases we obtained a history of a tumor in the breast which had remained unchanged for a period of years, sometimes as many as twenty, and then became an active carcinoma. It seems wise, therefore, to regard this type of tumor as potentially carcinoma.

Another condition found in the breast of younger women, is that of multiple cysts. Increasing experience leads me to look with very great suspicion upon this condition, because I am convinced that they not infrequently are precursors of carcinoma.

A single cyst is not nearly so apt to become carcinoma: in fact, a single cyst may be looked upon as practically the only innocent growth in the breast.

Tuberculosis of the breast is exceedingly uncommon, and syphilis of this region is a negligible quantity. We may say, therefore, that any lump in a woman's breast is a serious matter, and that unless we are able to convince ourselves that we are dealing with a single cyst, radical measures are indicated.

*Need of Careful Examination of Specimens.*—For quite a number of years all of the specimens removed have been subjected to careful microscopic examination, and these have led to the knowledge that carcinomatous change in the fibro-adenoma can almost always be detected, provided the examination is made thorough enough.

A point of very great importance from a prognostic standpoint, is the physical characteristics of the growth. A comparatively soft, succulent, rapidly growing tumor is far more malignant and less amenable to treatment than the hard, slowly growing variety.

One may say that as a general proposition the younger the patient the more likely the growth will be rapid and the malignancy great, and the older the patient, the less apt is the growth to be rapid or highly malignant. Carcinoma of the breast in women under thirty-five almost always pursues a rapidly fatal course.

The two following case histories illustrate the reversing of the rules just given above.

CASE I.—Mrs. D., the wife of a physician, was a robust, husky woman, forty-one years of age, who discovered a nodule in the outer, upper quadrant of her right breast. When I first saw her on April 13, 1910, there was a lump about the size of a buckeye in the outer, upper quadrant of her right breast, and the glands in her axilla were palpably enlarged. A radical operation was performed on April 14th, the day after I saw her, and she went home on April 27th. The microscopic report of Dr. F. B. Samson was "very malignant carcinoma."

The patient had a very peculiar mental condition bordering upon melancholia, and this condition was very marked both before and after operation. This patient is alive, well and free from any recurrences to-day (more than six years after the operation).

CASE II.—Miss B., a school teacher, was fifty years of age

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when she consulted me about a lump about the size of a hazelnut, in the outer, upper quadrant of the right breast. The axillary glands were not involved. The patient was a thin, wiry woman, with no personal history of any value, except that of pulmonary tuberculosis early in life. She had no history of trauma, and her family record was entirely free from any history of malignant disease. The microscopic report by Dr. C. F. Hegner was "small-celled medullary carcinoma—very malignant."

The patient had local, regional and distant recurrences. She died in about two years of metastases in the lung and elsewhere.

The strange and striking feature of my private cases, is the number of patients that have given a history of perfect health up to the time of the development of a lump in the breast. This statement has been made to me so often that I have been led to the belief that cancer most often affects the robust, and that it is more rapidly fatal in this class of patients.

*Pathology.*—The more one becomes acquainted with this disease the more uncertain he becomes in his ideas of pathology. He begins to doubt the value of much of our knowledge, and is apt to fall back upon the unsatisfactory statement that clinical results cannot be forecast accurately by microscopic findings. This, however, is merely begging the question, because, as a rule, clinical and pathologic findings do correspond very closely.

It is highly probable that certain types of individuals resist more effectually the inroads of cancer than do others. The nature of this resistance is entirely speculative, but some people seem to be much better culture media (if one may be permitted to use that term) than are others. This difference in susceptibility may be due to a chemical, rather than a physical composition of the individual, and I am inclined to believe that this difference in chemical types is much more important than the picture shown under the microscope. To express the idea in a different way, one may say that some cancers grow rapidly and possess certain histologic features, while others grow more slowly and possess different characters under the microscope, because in the one case the host furnishes a very fertile soil for the growth of cancer while the other possesses a soil not so well adapted to the neoplasm. A further fact tending to prove the existence of a soil favorable to the development of carcinoma, is that quite a number of cases made complete recoveries from the original growth, after operation, only to succumb to carcinoma in another locality, years afterward.

In one of my cases, a carcinoma was removed from one breast.

and thirteen months afterwards, carcinoma developed in the opposite breast. The second breast was then removed and the patient remained free from any trouble for twelve years, but at the expiration of that time, developed a carcinoma of the stomach which proved fatal.

The lapse of time in a case such as this, is too great to permit of the belief that the condition in the stomach was a continuation of the original disease in the breast.

I have had several such cases and they seem to indicate a predisposition of the tissues to the development of carcinoma.

May we not go a step further and say that apparently most persons possess a soil upon which cancer cannot thrive?

It is quite possible, though not as yet capable of demonstration, that the cause of the so-called change from a fibro-adenoma into a carcinoma, is not in the tumor but in a change in the chemistry of the organ in which it is placed. The change in the character of these growths is apt to take place at, or near, the time when a very profound change is taking place in the entire economy of the woman. Is it not more logical to suppose that the tumor finds its pabulum much more acceptable at that time, than it is to assume that there is a subtle change inherent to the growth itself?

To my mind the closest analogy to the development of cancer is that shown by the organs of generation. These organs remain immature and undeveloped for years and then suddenly undergo a transformation that is truly wonderful. Has anybody ever given an explanation for this marvellous change? I know of none that is satisfactory, but I am willing to prophesy that a similar stimulus (chemical?) will be found to account for the development of carcinoma at or near the time of the menopause.

Investigations along chemical lines will probably prove of very much more value than investigations along purely histologic lines. The histology of tumors is probably as well worked out at the present time as it will ever be, but chemical investigation in connection with these growths is but beginning.

#### ANALYSIS OF 100 CONSECUTIVE CASES

I present for your consideration an analysis of 100 consecutive cases of carcinoma of the breast, upon whom I have operated and of whose records I have been enabled to obtain a complete account. These cases were all private cases.

I have not attempted to draw any lessons from Hospital cases

## CARCINOMA OF THE BREAST

because of the extreme difficulty of following them sufficiently long to know of the final results.

Before presenting the analysis of the statistics I desire to say that the nature of the operation has shown quite a number of variations according to the peculiarity presented by individual cases. I have not attempted to follow any one technic, but have tried to adapt the incision to the case in hand.

In all of these cases passive movements of the arm have been begun within two or three days after the time of operation. The endeavor has been to have free use of the arm at the end of three weeks. In some of the early cases, immobilization of the arm was resorted to during the time of the healing of the wound. This method was abandoned because of the difficulty of obtaining good use of the arm later on. The only disadvantage that can be ascribed to the early use of the arm, is the possible collection of serum under the scar. This has never proved a matter of any serious import, because the serum can be easily drained off through the line of incision.

*Age.*—The ages of the patients have varied from 20 to 80. Between the ages of 20 and 30 four cases have been encountered; 10 between 31 and 40; 38 between 41 and 50; 29 between 51 and 60; 14 between 61 and 70; 3 between 71 and 80.

From these figures it can easily be seen that the vast majority of cases have occurred between the ages of 40 and 60.

In 56 of the cases the disease was in the right breast. In 43 the left breast was the seat of carcinoma, and in 2 both breasts were affected. These figures indicate less of a difference between the right and left breast than is found in some statistics.

The outer upper segment was the seat of growth in 32 cases; the disease was central, which also includes the total involvement of the breast, in 23 cases. The upper inner segment was the primary seat in four; the lower middle in five; the upper middle in four; the entire outer segment in nine; the inner lower in two; the lower outer in seven, and the entire inner half in one.

The time between the discovery of the growth and operation was as follows: 20 years, 2; 17 years, 1; 10 years, 4; 8 years, 1; 5 years, 2; 4 years, 1; 3 years, 2; 2½ years, 1; 2 years, 7; 1½ years, 5; 1⅓ years, 1; 1¼ years, 2; 1 year, 15; 10 months, 3; 9 months, 4; 8 months, 3; 6 months, 7; 5 months, 1; 4 months, 5; 3 months, 8; 2 months, 3; 7 weeks, 1; 6 weeks, 4; 5 weeks, 1; 4 weeks, 3; 3 weeks, 1; 2 weeks, 1; 1 week, 2.

The actual number of cases which have survived the three-year



period, is forty-one. The known dead are sixty-five, and in four the result is unobtainable.

Of those living, 1 is alive twenty-one years after operation; 3, fourteen years; 3, fifteen years; 1, thirteen years; 1, twelve years; 1, ten years; 3, eight years; 5, seven years; 3, six years; 3, five years; 3, four and a half years; 3, four years; 5, three and a half years; 1, three and a quarter years; 2, three years.

The successful cases knew of the existence of the disease, previous to the operation: 1, seventeen years; 1, ten years; 1, nine years; 1, eight years; 1, two years; 2, one and a quarter years; 5, one year; 1, nine months; 2, eight months; 4, six months; 2, four months; 4, three months; 2, two months; 1, seven weeks; 1, six weeks; 3, four weeks; 2, one week; 7, unknown duration.

It is interesting to note that twenty-two of the successful cases knew of the existence of the disease for nine months, or less, previous to operation, while twelve of them gave a history extending over from one to twelve years. The difference in the result is not nearly so striking as one would imagine it would be.

*Recurrences.*—The recurrences after operation exhibit a wide range. In fourteen cases the metastases were internal, this group including both the chest and abdominal recurrences. Seven had secondary deposits in the spine; two in the mediastinum; one in the brain; one in the skull; one in the lower jaw, and one in the sternum and supraclavicular fossa. Nine of the cases had purely local recurrences, and eight of them had local and internal recurrences. The other breast was secondarily involved in one case.

The following shows the time between operation and death in those cases which terminated fatally: 1, twelve years; 1, eleven years; 1, eight years; 1, five years; 4, four years; 1, three and a half years; 3, three years; 1, two and a half years; 2, two years and three months; 6, two years; 1, one year and nine months; 1, one and a half years; 1, one year and five months; 3, one year and three months; 1, one year and two months; 2, one year; 1, eleven months; 1, ten months; 4, nine months; 3, eight months; 1, seven months; 5, six months; 2, five months; 2, four months; 1, three months; 1, four months; 1, one-half day.

An item of interest is that in the first fifty cases operated upon, thirteen recovered and remained well. In the second fifty, twenty-eight cases are alive and well (three or more years after operation). Of the first twenty-five cases, six remained well; of the second twenty-five, seven; of the third twenty-five, twelve; of the fourth

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twenty-five, sixteen are alive and well (three or more years after operation).

In but three of these cases have recurrences appeared after three years. In one case a mediastinal carcinoma developed four years after operation. In another case a local recurrence was found, and removed, five years after operation, and in one case, carcinoma of the stomach developed eleven years after operation.

These figures indicate that a patient who has passed the three-year limit is pretty safe from subsequent recurrences.

My experience with X-ray treatment of these growths leads to the belief that it is of little, if any, value previous to operation. I am inclined to look with much favor upon the post-operative use of the X-ray in these cases, but my experience in this method of treatment has not extended over a sufficient length of time to justify anything like a positive expression of opinion. I have seen enlarged glands disappear from above the clavicle, but one must always bear in mind the possibility that they may not have been cancerous. This assumption has been borne out by the fact that some glands do not disappear under X-ray therapy.

I shall continue to recommend systematic post-operative X-ray treatment to all of my patients because of its possible benefit.

I have had no experience with the use of radium.

# JOHN CHADWICK OLIVER

No.	Name	Time between discovery and operation	Breast affected	Segment of breast	Rapidity of growth	Glandular involvement at the time of operation	Time of recurrence	Sites of recurrence	Time between operation and death	Alive	Age
1	Mrs. B.	15 months	Right	Upper outer	Rapid	Extensive	6 months	Axilla	2 years, 3 months, 6 months	.....	43
2	Mrs. S.	1 year	Right	Whole breast	Rapid	Extensive	3 months	Axilla and stomach	2 years	.....	78
3	Mrs. F.	3 months	Right	Upper outer	Rapid	Slight	3 months	Local and internal	2 years	.....	39
4	Mrs. D.	1 year	Right	Upper outer	Rapid	Marked	3 months	Liver and pleura	3 months	.....	39
5	Mrs. A.	1 year	Left	Upper inner	Rapid	None	1 year	Spine	1 year	.....	55
6	Mrs. B.	3 years	Right	Upper outer	Moderate	Marked	2 weeks	Brain	4 weeks	.....	49
7	Mrs. B.	6 weeks	Right	Upper inner	Rapid	Slight	6 months	Stomach and liver	14 months	.....	58
8	Mrs. C.	20 years, active 12 years	Left	Upper outer	Slow	Moderate	1 1/2 years	Liver	21 months	.....	53
9	Mrs. K.	6 months	Right	Lower middle	Rapid	Slight	14 months	Axilla (second operation)	.....	21 years	44
10	Mrs. V.	1 year	Right	Lower	Moderate	Slight	.....	.....	.....	14 years	62
11	Mrs. D.	2 years	Right	Upper outer	Moderate	Marked	.....	.....	.....	.....	.....
12	Miss K.	1 year	Right	Upper outer	Slow	Slight	2 years	Other breast	.....	.....	53
13	Miss K.	2 years	Left	Upper	Slow	Slight	11 years	Stomach	12 years	.....	65
14	Mrs. R.	9 months	Right	Outer	Rapid	Extensive	2 years	Abdomen	3 years	.....	56
15	Mrs. P.	3 months	Left	Upper outer	Rapid	Slight	2 years	Spine	3 years	.....	49
16	Mrs. P.	3 months	Right	Upper outer	Rapid	Slight	2 years	Skull	3 years	.....	56
17	Mrs. W.	5 weeks	Right	Lower	Rapid	Moderate	3 years	Mediastinum	4 years	.....	65
18	Mrs. M.	6 months	Left	Outer	Moderate	Slight	3 years	?	5 years	.....	64
19	Mrs. G.	18 months	Right	Middle	Slow	Slight	3 years	Local (removed)	4 years	.....	65
20	Mrs. T.	2 1/2 years	Right	Inner lower	Slow	Extensive	5 years	Stomach	6 months	15 years	47
21	Mrs. H.	2 years	Right	Recurrence of axilla	Slow	Extensive	.....	.....	.....	14 years	55
22	Mrs. W.	4 months	Right	Upper outer	Moderate	Moderate	.....	.....	.....	14 years	44
23	Miss F.	1 year	Right	Upper outer	Rapid	Extensive	16 months	Local and internal	2 years	.....	48
24	Mrs. B.	3 months	Right	Recurrent	Rapid	Extensive	?	Lung	9 months	.....	49
25	Mrs. D.	3 months	Right	Lower outer	Slow	Slight	.....	?	.....	13 years	65
26	Miss H.	1 year	Left	Total	Rapid	Extensive	?	?	15 months	.....	58
27	Mrs. B.	8 months	Right	Upper outer	Rapid	Extensive	2 years	Jaw	3 years	.....	63
28	Miss S.	2 years	Right	Upper outer	Rapid	Extensive	10 years	Stomach and liver	11 years	.....	58
29	Mrs. P.	1 year	Left	Upper outer	Rapid	Very extensive	?	?	6 months	.....	65
30	Mrs. W.	6 months	Left	Upper outer	Rapid	Slight	.....	.....	.....	12 years	47

Could not be traced.

# CARCINOMA OF THE BREAST

31	Mrs. R.	6 months	Right	Lower outer	Rapid	Extensive	.....	Local	8 months	3 1/4 years	68
32	Mrs. S.	10 months	Right	Entire breast	Rapid	Extensive	3 months	Local	9 months	42	
33	Mrs. M.	10 years	Left	Inner lower	Slow	Extensive	3 months	Local and lungs	6 months	48	
34	Mrs. T.	1 year	Right	Entire breast	Rapid	Moderate	3 months	Lumbar verte-	8 months	50	
35	Mrs. K.	1 year	Right	Upper outer	Rapid	Extensive	?	brae	8 months	43	
36	Mrs. I.	4 years	Left	Outer central	Slow	Extensive	?	Lumbar verte-	3 1/2 years	56	
37	Miss T.	2 years	Left	Entire breast	Slow	Extensive	1 year	Local right breast, medi-	18 months	40	
38	Mrs. T.	10 years	Right	Central	Slow	Extensive	.....	astinum	15 months	57	
39	Mrs. L.	6 weeks	Left	Lower outer	Rapid	None	2 months	Sternum and supraclavicular	1 year	51	
40	Mrs. R.	10 years	Right	Recurrent	Slow	Slight	7 years	Both breasts	8 years	38	
41	Mrs. M.	16 months	Right	Total	Rapid	Extensive	6 months	Locally and in lung	17 months	51	
42	Mrs. M.	1 year	Left	Lower outer	Rapid	Extensive	.....	.....	.....	69	
43	Mrs. C.	3 months	Left	Central	Rapid	None	.....	.....	.....	65	
44	Mrs. S.	5 months	Left	Upper outer	Rapid	Slight	.....	.....	.....	71	
45	Miss M.	18 months	Right	Upper outer	Rapid	Moderate	.....	.....	Dead	33	
46	Mrs. W.	1 month	Both	Middle lower.	Rapid	Extensive	.....	.....	.....	45	
47	Miss W.	7 weeks	Right	Upper outer	Rapid	Slight	.....	.....	.....	54	
48	Mrs. G.	4 months	Left	Inner	Rapid	Extensive	.....	.....	.....	not known	
49	Mrs. S.	5 years	Right	Total	Slow	Extensive	3 months	Spine	8 months	29	
50	Mrs. W.	18 months	Left	Median	Rapid	Slight	2 months	Liver	7 months	40	
51	Miss D.	6 weeks	Right	Lower outer	Rapid	Slight	.....	.....	.....	45	
52	Mrs. G.	17 years	Left	Middle	Slow. Six months rapid	Moderate	.....	.....	.....	47	
53	Mrs. H.	8 months	Right	Middle	Moderate	Slight	.....	.....	.....	43	
54	Mrs. S.	5 years	Right	Outer	Moderate	Extensive	3 months	? Locally, lung and general	9 months	58	
55	Miss B.	4 months	Right	Upper outer	Rapid	None	1 1/2 years	Internal Right breast and spine	2 1/2 years	50	
56	Miss I.	2 years	Right	Central	Slow	Slight	Not known	Locally	1 year	54	
57	Miss P.	4 months	Left	Central	Rapid	Extensive	1 year	Locally	15 months	45	
58	Miss F.	1 year	Right	Upper central	Rapid	Extensive	5 months	.....	1 year	57	
59	Mrs. C.	8 months	Right	Upper outer	Rapid	Extensive	.....	.....	.....	69	
60	Mrs. G.	1 year	Left	Upper central	Moderate	Slight	.....	.....	.....	54	
61	Mrs. D.	1 week	Right	.....	Slow	None	.....	.....	.....	49	
62	Mrs. D.	2 months	Left	.....	Rapid	None	.....	.....	.....	Adenoma re-	
63	Mrs. J.	?	Right	Total	Rapid	Extensive	.....	.....	.....	moved	
64	Miss N.	2 months	Left	?	Rapid	Slight	.....	.....	1/2 day	twenty years	
65	Mrs. J.	?	Right	.....	.....	Slight	1 year	Liver	2 years	49	
										47	
										45	
										58	

Died cerebral  
hemorrhage.  
Result not  
known.

Result not  
known  
Has new  
growth in  
axilla.

Recurrence in  
right axilla  
after 7 years.

Adenoma re-  
moved  
twenty years

# JOHN CHADWICK OLIVER

No.	Name	Time between discovery and operation	Breast affected	Segment of breast	Rapidity of growth	Glandular involvement at the time of operation	Time of recurrence	Sites of recurrence	Time between operation and death	Alive	Age	
66	Mrs. R.	9 months	Right	Central	Rapid	Extensive	8 months	Local and distant	2 1/4 years	6 years	48	
67	Miss B.	20 years, active 18 months	Right	Outer	Rapid	Extensive				.....	50	
68	Mrs. A.	3 months	Left	Upper outer	Rapid	Extensive	3 months	Spine	9 months	.....	46	
69	Mrs. B.	9 months	Left	?	Rapid	Extensive	.....	Lung	5 months	.....	63	
70	Mrs. A.	6 weeks	Left	Entire	Rapid	Extensive	.....		6 months	.....	59	
71	Mrs. W.	2 years	Right	Entire	Moderate	Extensive	.....	Stomach	5 months	.....	31	
72	Mrs. D.	1 1/2 years	Left	Total central	Rapid	Extensive	Very soon	Local	4 months	.....	45	
73	Mrs. B.	1 year	Left	Central	Rapid	Extensive	2 years		4 years	.....	52	Pernicious anaemia.
74	Mrs. W.	9 years	Right	Central	Slow	Slight	.....		.....	6 years	51	
75	Mrs. D.	1 week	Right	Upper outer	Rapid	Moderate	.....	Locally and in neck and thorax	.....	6 years	41	
76	Mrs. K.	10 months	Left	Upper outer	Slow	Extensive	11 months		2 years	.....	52	
77	Mrs. C.	?	Left	Upper outer	Slow	Slight	.....		.....	5 years	63	
78	Mrs. J.	?	Right	Upper outer	Slow	None	.....		.....	5 years	50	
79	Mrs. C.	2 weeks	Left	Upper outer	Rapid	Extensive	?	?	2 years	.....	41	Pernicious (?) anaemia.
80	Mrs. H.	?	Right	Upper inner	Slow	Slight	.....		.....	5 years	48	
81	Miss F.	10 years	Right	Upper outer	Slow	Slight	.....		.....	4 1/2 years	45	
82	Mrs. M.	2 months	Right	Upper outer	Rapid	None	.....		.....	4 1/2 years	30	
83	Mrs. S.	1 year	Left	?	Slow	None	.....		.....	4 1/2 years	56	
84	Miss W.	6 months	Right	Upper inner	Rapid	None	.....		.....	4 years	26	
85	Miss P.	4 months	Left	Outer lower	Rapid	Moderate	.....		.....	4 years	38	
86	Miss B.	?	Left	Upper outer	Rapid	Moderate	.....		.....	4 years	45	
87	Miss B.	3 months	Right	Upper outer	Rapid	None	.....		.....	.....	48	
88	Miss C.	1 month	Left	Outer central	Rapid	Moderate	.....		.....	4 years	47	
89	Mrs. A.	8 years	Right	?	Slow	Slight	.....		.....	3 1/2 years	52	
90	Mrs. R.	3 months	Right	?	Rapid	Moderate	.....		.....	3 1/2 years	37	
91	Miss C.	6 months	Left	Total	Rapid	Moderate	.....		4 months	.....	56	
92	Mrs. S.	3 months	Left	Upper central	Moderate	Extensive	.....		.....	3 1/2 years	57	
93	Mrs. F.	?	Left	Lower	Slow	None	2 years	Local	.....	3 1/2 years	77	
94	Mrs. J.	15 months	Left	Outer	Slow	Slight	1 year	Nodule in axilla	.....	3 years	50	
95	Mrs. D.	3 years	Left	?	Slow	None	.....		10 months	.....	51	
96	Mrs. Z.	?	Right	Upper outer	Slow	Extensive	.....		11 months	.....	56	
97	Mrs. S.	10 months	Left	Upper outer	Slow	Extensive	?	Spine	4 years	.....	50	
98	Miss R.	?	Left	?	Slow	None	.....		.....	4 1/2 years	23	
99	Mrs. G.	?	Right	Central	Slow	None	.....		.....	3 1/2 years	38	
100	Miss P.	1 month	Left	Upper outer	Rapid	Moderate	.....		.....	3 years	36	

# AUTOGENOUS FASCIAL RECONSTRUCTION OF THE BILE-DUCT\*

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AND

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THE history of the patient, the subject of the title of this contribution, is as follows:

Mrs. E. S., thirty-six years of age, white, No. 28816, was admitted to the Polyclinic Hospital, February 29, 1916. Discharged June 10, 1916. Diagnosis, cholelithiasis.

*First Operation* (March 6, 1916).—Through an upper right rectus incision, the gall-bladder was found to be atrophic, with a fundus shrunk to about the size of an English walnut, containing a few soft friable calculi. The body of the gall-bladder was elongated, and scarcely greater in diameter than the cystic duct. There were numerous adhesions between this organ and the colon and duodenum, presenting evidence of previous attacks of cholecystitis. The massive fatty omentum was found adherent to the urinary bladder. The appendix had been removed at a previous operation. There was no other evidence of abdominal disease.

Cholecystectomy was performed. The forceps which presumably included only the cystic duct were first inserted between this structure and the liver as suggested by Judd. The common duct, to which the cystic duct was parallel, was caught in the forceps applied to the cystic duct, and both structures were divided in the course of removal of the gall-bladder. The distal end of the common duct was included in the ligature which embraced the cystic artery, while the proximal end remained free. A Mikulicz drain was inserted into the region of the foramen of Winslow, and a split rubber tube was introduced into the kidney pouch of Morrison.

An examination of the gall-bladder and cystic duct immediately following the operation disclosed the accident which had occurred, since the terminal portion of the cystic duct included a small part of the wall of the common bile-duct. Our fears were confirmed twenty-four hours later by the presence of a

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\* Read before the Philadelphia Academy of Surgery, October 2, 1916.

profuse discharge of bile through the abdominal wound; and the first bowel movement, three days later, was decidedly of the clay-colored type. At no time following this operation did any bile appear in the stools; the drainage through the abdominal wound being excessive. Satisfactory healing of the incision took place, except for the establishment of a biliary fistula. The patient made a good operative recovery.

*Second Operation* (March 15, 1916).—Nine days following the first operation, the abdomen was reopened through an incision mesial to the previous scar, and careful dissection of the gall-bladder fossa and gastrohepatic omentum was made. The distal end of the common bile-duct was readily found. After considerable difficulty the proximal end of the duct was isolated. Examination showed that division of this structure had taken place half a centimetre below the junction of the right and left hepatic ducts, with some loss in continuity of the duct wall.

Since apposition of the two ends of the bile-duct was impossible, a T-shaped rubber tube was inserted into the proximal and distal ends of the bile-duct, and fixed by catgut sutures. About two inches of the duct needed reconstruction, and this was accomplished by enveloping the rubber tube with a section of posterior rectus sheath fascia, including the peritoneum, taken from the region of the wound. The fascial surface of the transplant was placed in contact with the rubber tube, and both ends were carefully sutured to and around the proximal and distal ends of the bile-duct, and also to the wall of the duodenum. A small rubber drain was placed down to the foramen of Winslow, but not in contact with the newly constructed duct. Bile drainage through the T-tube took place within twenty-four hours, with no leakage around the tube, and the first bowel movement, two days later, showed the presence of bile. For one week following this operation the stools were bile-stained, but thereafter became clay-colored.

Since after this date bile was draining profusely through the tube, and the stools failed to show any trace of bile, it was concluded that the distal end of the tube had broken away, and that further reconstruction of the duct would be necessary.

On the eighth of April, the wound had completely healed around the T-tube, which was draining freely into a bottle. The patient was able to walk, and had lost little weight or strength in spite of her meat-free diet. Until the time of the third operation, on May 23, careful studies of the patient's stools were made, and accurate records of the bile discharge into the bottle through the T-tube were kept. No bile appeared in the stools later than the first week after the second operation, and the amount collected



FIG. 1.—Small shrunken gall-bladder. Cystic duct in close proximity and paralleling the common duct. Case reported in this article.

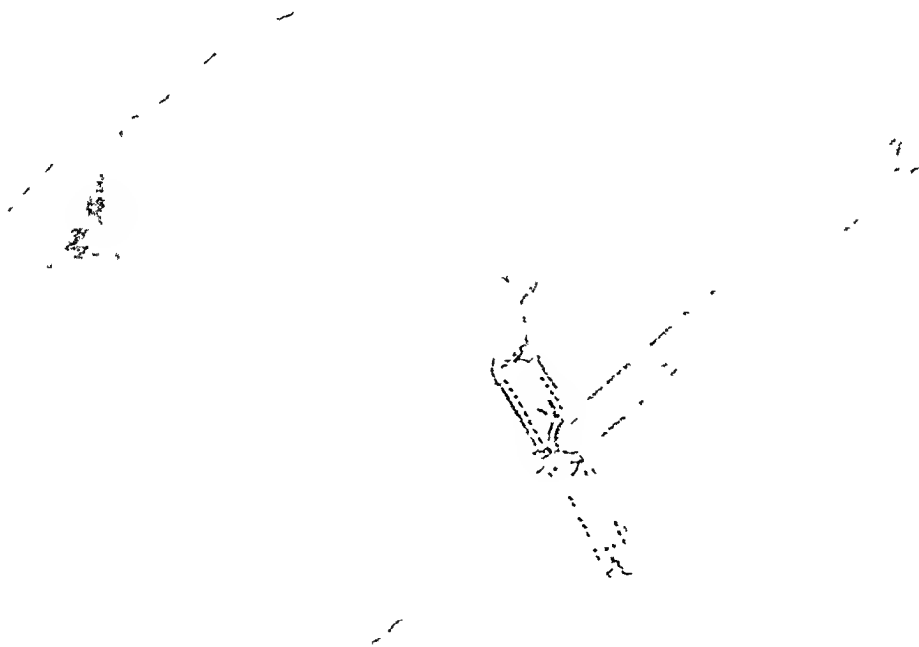


FIG. 2.—Suture of divided common duct around the T-tube of rubber. A simple method of uniting a divided common duct when too much strain is not placed upon the approximation sutures.



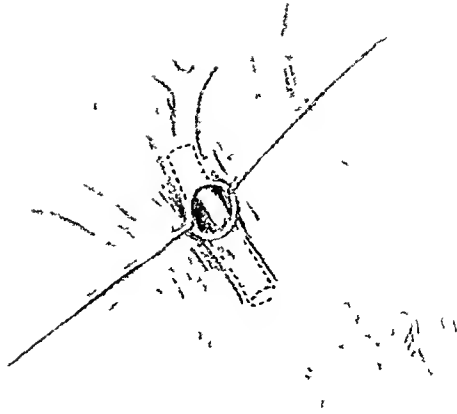


FIG. 3.—Union of divided common duct around the rubber tube, which should pass down into the duodenum. Final closure of the duct is accomplished without necessitating a withdrawal of the T-tube and the subsequent danger of cicatricial stenosis of the bile-duct.

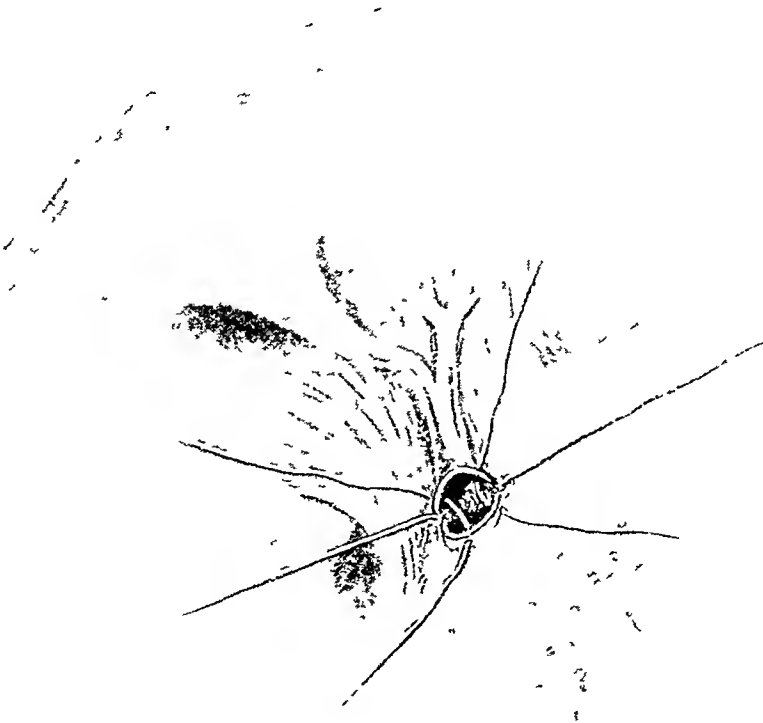


FIG. 4.—Direct suture of the bile-duct into the lumen of the duodenum when sufficient mobilization of the bowel can be accomplished.

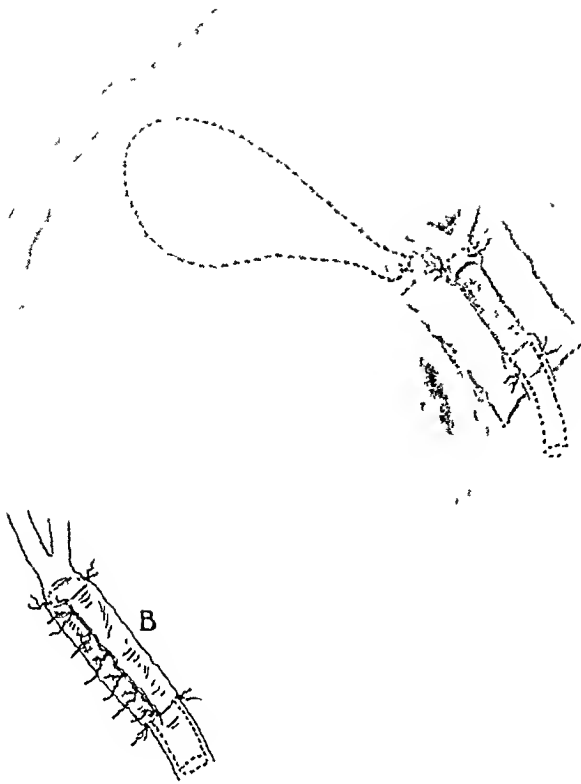


FIG. 5.—Fascial transplant sutured to the proximal and distal ends of the bile-duct into which a rubber tube had been introduced for reconstruction of the bile-duct following cholecystectomy. The graft is sutured securely at both ends; but is not sutured to the rubber tube, which should be passed through the ampulla of Vater.

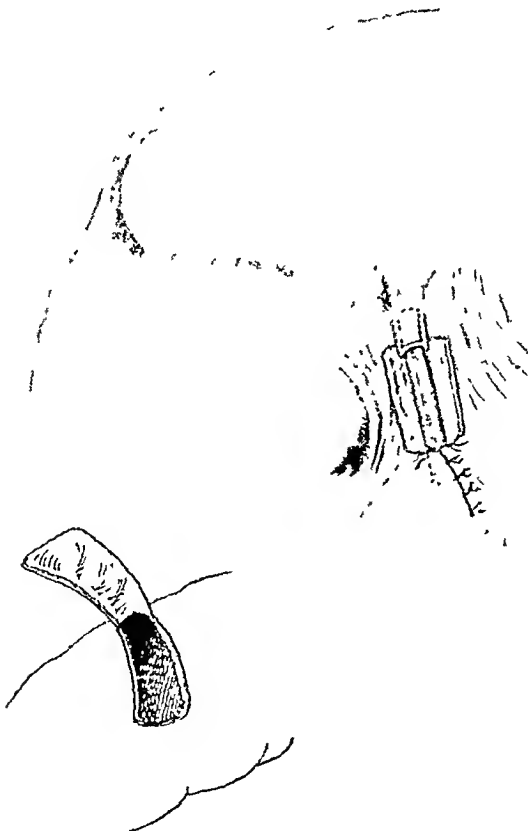


FIG. 6.—Modified Walton operation. Note the duodenal flap with the pedicle above placed behind the rubber tube introduced into the bile-duct and directly into the duodenum. The bowel is sutured up to the point of implantation of the tube.



FIG. 7.—Later stage of the modified Walton operation, showing the suture of the duodenal flap to the proximal portion of the common duct, and also around the rubber tube. The suture line is anterior and the reconstruction is made easier by employing this modification.

## RECONSTRUCTION OF THE BILE-DUCT

in the bottle varied from ten to eleven ounces for twenty-four hours.

*Third Operation* (May 23, 1916).—An incision extending from the ensiform cartilage to the umbilicus opened the abdominal cavity to the median side of the previous right rectus incision. There were dense vascular adhesions between the stomach, duodenum, transverse colon, and great omentum, and the parietal peritoneum. These adhesions were carefully divided in order to facilitate the mobilization of the pyloric segment of the stomach and the upper duodenum.

Employing the T-tube introduced at the previous operation as a guide, the dissection was carried down to the right border of the gastrohepatic omentum. The reconstructed bile-duct was readily isolated and the examination showed that the distal end of the T-tube had broken away at the junction of the fascial transplant with the distal end of the common duct, and was impinging upon the wall of the duodenum. A curved forceps was passed through this portion of the duct into the duodenum, and no evidence of obstruction was found. The T-tube was removed from the common duct, bile flowing freely throughout the operation. A small thick-walled rubber tube, slightly less in diameter than that of the common duct itself, was substituted for the T-tube, and the bile-duct reconstructed around this tube, carefully suturing the transplant to the distal portion of the bile-duct as well as to the wall of the duodenum.

Closure of the duct over the tube was easy of accomplishment, only a few fine catgut sutures being required. Before the rubber tube was passed into the proximal end of the bile-duct, a few syringefuls of salt solution were injected into the rubber tube passed through the ampulla into the duodenum. The gastrohepatic omentum was sutured over the duct to reinforce the line of sutures.

The most difficult feature of the operation was the separation of the adhesions encountered upon entering the abdomen, since the isolation of the distal end of the common duct and the later introduction of the rubber tube were easily accomplished, owing to the presence of the T-tube, which was employed as a guide to the site of the duct. Nature had apparently accepted the fascial transplant and thoroughly reconstructed the common duct, and we believe that if the distal end of the rubber tube, introduced at the second operation, had been passed into the duodenum, bile delivery into the intestine would have persisted. Convalescence was uninterrupted except for some slight superficial infection in the wound.

*Fourth Operation* (August 17, 1916).—Careful examinations of the stools up to this time failed to reveal the presence of the rubber tube introduced into the common duct at the third operation. Radiographic examination showed adhesions of the stomach and intestine to the anterior abdominal wall. The patient complained of upper abdominal distress following the ingestion of food, and requested another exploration for relief of her symptoms. Excision of the old scars was performed and the upper abdomen was opened. There were extensive adhesions between the upper jejunum, and anterior surface of the stomach, transverse colon and the anterior abdominal wall. These organs were carefully dissected free, and examination of the duodenum in the region of the common duct was made. The rubber tube in the common duct was easily felt passing into the retroduodenal portion of the duct. The duodenum was opened about one inch from the pylorus, and, in spite of carefully directed attempts at palpation, the end of the rubber tube could not be felt in the duodenum for purposes of extraction. The patient was not suffering from common duct crises, and since incision of the reconstructed duct for removal of the tube was not considered feasible, it was deemed advisable to close the duodenal wound, and not attempt the removal of the tube. A small rubber tissue drain was introduced down to the seat of the duodenal incision, and the abdomen closed.

Two days following the operation the patient developed free biliary flow through the drainage tract occupied by the rubber dam. The stools were clay-colored for a period of three or four days, but on August 30, a stool showed copious delivery of bile into the duodenum, and from this time on there was scarcely any drainage through the abdominal wound. It is evident that some injury of the newly-made common duct occurred at this operation through the separation of adhesions, but fortunately was not sufficient in extent to jeopardize the integrity of the recently constructed bile-duct. The patient left the hospital with a well-healed wound, and all bile passing into the duodenum. At the present time, four months since the successful reconstruction of the duct was accomplished, the rubber tube has not been passed, and the patient has not suffered from any symptoms suggestive of biliary colic.

Accidental division or injury of the common bile-duct has occurred in many instances during the course of removal of the gall-bladder. Numerous contributions to surgical literature have recently appeared, dealing with the operative repair of the bile-duct for a deficiency which has resulted from accidental division, or partial excision necessitated

## RECONSTRUCTION OF THE BILE-DUCT

by the presence of a pathologic process obliterating the lumen of the duct.

The cystic duct lies in a fold of the gastrohepatic omentum, which normally passes over, to the pelvis of the gall-bladder, and obscures the duct from view. In order to insure the integrity of the common duct when cholecystectomy is performed, the cystic duct must be isolated for accurate ligation. The importance of this observation has been emphasized by Moynihan, Judd, Brewer, Deaver, and others, who have graphically illustrated operations for removal of the gall-bladder. W. J. Mayo, in a classic contribution upon this subject, has emphasized the important anatomical relationship between the pelvis of the gall-bladder and the cystic duct over which it lies. Grasping and elevating this little dilatation will usually render the cystic duct tense and make its isolation a simple procedure.

There is still some difference of opinion as to whether cholecystectomy is not more safely performed by primary dissection of the gall-bladder from its hepatic fossa, as a preliminary step to the isolation and ligation of the cystic duct. To obviate the danger of accidental division of the common duct when the gall-bladder is removed, the cystic duct should be freely exposed in its enclosed fatty fold of the gastrohepatic omentum and clamped, either including the cystic artery in the forceps, or with separate ligation of each structure. Any procedure which includes the cystic artery and the cystic duct in a single pedicle ligature, without first exposing and clearly defining the duct, will carry with it the hazard of accidentally injuring or actually dividing the common bile-duct.

It seems to us that the most important feature in the technic of cholecystectomy lies in this step of the operation, and does not bear upon whether dissection of the gall-bladder for removal begins above or below. When one can safely isolate the cystic duct, without the danger of injury to the common bile-duct, it is easier to do a sub-peritoneal dissection of the gall-bladder from below upwards, suturing the fossæ as the dissection proceeds towards the inferior border of the liver.

Partial choledochus excision occasionally becomes necessary for benign strictures of the bile-duct; or when the obstruction to the biliary flow is complete, owing to an impassable mechanical barrier either in the head of the pancreas or at the ampulla of Vater. When the latter condition obtains, cholecystenterostomy is the operation of choice, and should take precedence over any attempt at reconstruction of a new bile-passageway.

The immediate repair of the bile-duct, when division is promptly recognized during the course of cholecystectomy, is a simpler procedure than that which follows at a second sitting in the presence of altered anatomical relations, and well organized adhesions between the inferior surface of the liver and the adjacent viscera. Separation of these vascular adhesions is difficult and time-consuming, and the operative procedure carried on in a deep-seated region is handicapped by the absence of the gall-bladder which always serves a valuable purpose for exerting traction upon the liver, and thereby elevating the gastro-hepatic omentum with its enclosed contents.

As a rule, the operative accidental injury or total division of the common duct is not discovered at the time of the primary operation, but its existence is suggested by the early and persisting biliary fistula which follows, associated with total absence of bile in the stools.

The immediate necessity for suture or reconstruction of the bile-duct is not great, since patients with biliary fistula and total absence of bile in the intestine may go on for many months showing little loss of strength or weight. In our own case, the patient developed a biliary fistula lasting many weeks, during which time she discharged all of her hepatic secretion through the wound, and showed no evidence of bile in the intestine. On a meat-free diet she lost but little weight, and other than the inconvenience of her soiled clothing suffered no other ill-effects.

The methods of repair of an injured bile-duct are numerous, and the selection of a particular type of operation is largely dependent upon the features of the individual case and the degree of destruction of the bile-passage which is present. The factors which determine the facility of repair are: Slight injury to the wall of the duct; total division without loss of tissue; and, finally, inability to appose the ends of the bile-duct after division associated with the loss of part of the drainage tract.

The early operations suggested and performed by Riedel, Sprengel, and others, employing lateral anastomosis between the bile-duct and the duodenum either with or without the Murphy button, have chiefly an historical interest and do not afford a simple and certain means of overcoming the difficulty present.

The most satisfactory results have been accomplished during the past ten years; employing methods of repair or reconstruction, of which the following are those attended by the greatest measures of success.

1. *Direct Suture*.—Direct suture of the bile-duct, when recogni-

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tion of the division during the course of an operation takes place, can be accomplished by through-and-through chromic catgut sutures similar to the end-to-end anastomosis of a blood-vessel by the method of Carrell. The gastrohepatic omentum should be grafted over the suture line in order to lessen the danger of leakage, and when too much tension does not exist this procedure should suffice. The ease of accomplishment is largely dependent upon the degree of tension to which the sutures are subjected, and the absence of inflammatory changes in the gastrohepatic omentum. Post-operative cicatricial stenosis occurring at the suture line may result after this procedure.

C. H. Mayo has suggested and carried out longitudinal splitting of the distal segment of the bile-duct for a short distance, in order to increase its calibre and render coaptation easier of accomplishment. W. J. Mayo has shown the advisability of employing a T-tube, introduced into the sutured bile-duct for the purpose of establishing drainage until such time as reconstruction of the biliary channel has been accomplished. He emphasizes the importance of directing the distal end of the T-tube through the ampulla into the duodenal lumen, proving this has been accomplished by injecting salt solution through the tube in accordance with the suggestion of McArthur. The T-tube is allowed to remain in place for some weeks, being removed at the discretion of the operator.

This method, when it can be accomplished, is undoubtedly the safest and most satisfactory means of re-establishing the continuity of the common bile-duct following division, or excision of a portion of the duct.

2. *Hepaticoduodenostomy or Choledochoduodenostomy.*—Either of these procedures may be successful when partial excision of the distal portion of the common bile-duct has occurred, or if the patency of this channel is destroyed as the result of disease. Section of the duct above the stricture or obstructive factor with direct implantation into the lumen of the duodenum has been successfully carried out on a number of occasions.

Riedel, in 1881, first performed choledochoduodenostomy, employing a bilateral anastomosis between the bile-duct and the duodenum. This operation proved unsuccessful, owing to leakage of infected bile; but in 1891 Sprengel successfully sutured the bile-duct into the duodenum, having previously performed cholecystectomy.

In 1905 W. J. Mayo sutured the hepatic duct directly into the duodenum, and he has recently reported that the patient is alive and well. This operation has been repeated successfully by others, and is



a valuable method of re-establishing continuity of the bile-duct when sufficient mobilization of the duodenum is possible. However, when the persisting portion of the duct cannot be implanted directly into the duodenum, some other means must be selected to overcome this difficulty. Hepaticojejunostomy has been performed, employing a loop of jejunum in place of the immobile duodenum (Jackson).

Hepaticoduodenostomy has also been employed, a portion of the intestine, usually the duodenum, is sutured directly to the liver after a portion of this organ has been excised, in order to drain bile from the numerous small introhepatic bile-ducts directly into the intestine. The operation is contra-indicated, owing to the dangers of hemorrhage, infection of the liver substance, and the difficulty of successful suture. The mere mention of this procedure is sufficient to condemn it as being irrational and unscientific in its conception.

*Reconstruction of the Bile-duct by the Employment of a Rubber Tube with or without the Use of an Autogenous Graft.*—This method of repair is indicated in those cases in which division of this structure has taken place with wide separation of the proximal and distal ends, or when a portion of the duct has been excised owing to pathological changes which have occurred in or about the duct.

In 1909 A. G. Sullivan stated that no previous operation had been successfully devised, having for its purpose improvisation of a new duct, when the necessity was created as a result of accidental injury or disease. In his experimental laboratory work employing dogs, he introduced a rubber tube, about the size of a common duct, into the proximal end of this structure and fixed the distal end into a small opening in the duodenum. In placing the rubber tube across the wall of the duodenum, he attempted to create the supra- and retroduodenal relations of the bile-duct. The duodenal wall was sutured over the distal end of the tube, and, by employing gastrohepatic and great omentum, he reinforced his suture line and buried the rubber tube in these structures. His operation was really based upon the method which Hans Kehr, of Halberstadt, Germany, employed when he successfully sutured the gastric wall around a tube which he introduced into the common duct for a deficiency in the wall of this structure.

We believe that successful reconstruction of the bile-duct can be accomplished by means of a fascial transplant surrounding a rubber tube. If simple division of the duct has occurred, the distal end at the second operation is usually found unchanged with the orifice widely open. A rubber tube of proper size is sutured into the distal and proximal ends of the bile-duct. The autogenous fascial graft can

be taken from the posterior rectus sheath and will successfully re-establish the continuity of the biliary channel to a degree approaching the normal. The graft should be firmly and carefully sutured to the distal and proximal portions of the bile-duct and around the rubber tube introduced into the newly reconstructed channel. The distal end of the rubber tube should be passed through the ampulla into the duodenum and should not be fixed by sutures to the fascial graft.

When the distal end of the common duct, as a result of disease or injury, cannot be employed for this purpose, the rubber tube should be introduced into the duodenum through a small opening; and reconstruction accomplished as described. The autogenous graft is more advantageous than the employment of omental tissue, since, after the passage of the rubber tube, there remains a strong fascial tract, which is not subject to the same strictural possibilities as would be the case when strict adherence to the method of Sullivan is employed.

Lewis and Davis successfully employed fascial grafts taken from the abdominal wall in the reconstruction of injured bile-ducts, and reported satisfactory results in their experiments upon dogs. The appendix has been suggested by Molineux as a structure for the reconstruction of the bile-duct; and Giordano, Stropeni, Giacinto and Luigi have employed venous segments to re-establish continuity of the biliary passage where intentional division has been made in dogs. While the appendix is unsuitable for this purpose, laboratory experiments with venous segments have been reported as being successful.

The employment of a rubber tube of sufficient length, extending into the duodenum, surrounded by an autogenous fascial graft, seems to us to be the most satisfactory means of reconstructing either a part or the entire continuity of the bile-duct. The size of the tube and fascial graft are subject to no limitations. Mobilization of the duodenum is unnecessary and the operation is easy of accomplishment. The employment of a T-tube is not desirable, since it makes the reconstruction more difficult and the subsequent withdrawal of the tube will necessarily place considerable strain on the wall of the newly-established duct, creating serious damage, with the danger of subsequent cicatricial stenosis.

W. J. Walton has devised an ingenious operation which consists in indirect implantation. Employing a rubber tube sutured into the proximal end of the bile-duct and passing distally through the wall of the duodenum, he turns down a duodenal flap including the mucous surface of the bowel and sutures this around the distal end of the rubber tube, fixing the free border of the flap by interrupted sutures

to the remaining portion of the bile-duct above. This operation is really hepaticoduodenostomy, with a modification similar to that of Hans Kehr, which consists in employing a flap of tissue lined by mucous membrane from the stomach to line the newly created bile-duct.

We believe that the operation of Walton can be much improved by cutting the duodenal flap with the pedicle above instead of below, and placing it behind the rubber tube employed for reconstruction, so that the suture line will be on the ventral surface of the rubber tube instead of on the posterior aspect. This variation in technic will make the operation easier of accomplishment, and the suture line can be securely reinforced by grafting omental tissue on the newly-built bile-duct. The blood supply of a duodenal flap having its pedicle above will also be more abundant, since the superior duodenal border is richly supplied by branches of the upper pancreaticoduodenal artery.

## SPLENECTOMY FOR REPEATED GASTRO-INTESTINAL HEMORRHAGES

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THE following case is presented first to call attention to the advisability of considering the splenic factor in those cases of recurring gastro-intestinal hemorrhages in which the positive exclusion of gastric or duodenal ulcer the absence of both splenomegaly and a recognizable hepatic cirrhosis contribute to a difficult diagnostic problem, and, second, because I have been unable to find in the literature any record of splenectomy performed on similar indications.

CASE A-97895.—C. W. E. S., a male, aged forty-five, presented himself for examination in the Mayo Clinic, December 30, 1913. With the exception of a tuberculous infection of the cervical glands in early life, his past history, other than that relative to his present condition, was negative.

His immediate complaint was bloody stools. From his clinical record the following facts were abstracted: For twelve or fifteen years he had been subject to epigastric discomfort one or two hours after meals, accompanied by belching of gas with sour eructations. He had noted rather indefinite food relief, but it had never been so decided that he had purposely eaten to relieve the pain. The "indigestion" was not constant, there being periods of complete remission, such periods being of usually a month's duration. About three months previous to his examination, after an unusually severe spell of gastric distress, tarry stools were noticed. Two or three weeks later the stools again became black, and on this occasion dyspnoea on exertion, accelerated pulse, and anæmia resulted. On December 13, two weeks before he came to the Clinic a more profuse hemorrhage occurred.

The physical findings did not aid toward a clinical diagnosis. The essential reports in the special examination of the patient were as follows:

The fluoroscope demonstrated a healed tuberculosis of the apex of the right lung. The first fluoroscopic examination of the stomach was indeterminate. On second examination a possible ulcer on the posterior wall near the lesser curvature was reported. The proctoscopic report was negative. At times the urine showed a trace of albumin but red blood-cells and white blood-corpuscles were always present. The gastric secretions

were of normal acidity. There was a marked secondary anæmia, the blood record being hæmoglobin, 45 per cent.; red cells, 3,350,000; white cells, 5000. The Wassermann test was negative.

A diagnosis of duodenal ulcer was made. The diagnosis was based on the chronicity and the periodicity of the "indigestion" and the bloody stools. Operation was considered urgent on account of the repeated hemorrhages and the marked anæmia.

On January 13, 1914, the patient was explored. The operative findings were most unusual. The pyloric end of the stomach was markedly dilated and enormous varicose veins were present in this portion of the stomach and along the lesser curvature. There was a distinct œdema of the pancreas which extended into the neighboring lymphatic glands. Ulcer was not demonstrated. The gall-bladder, however, contained one stone impacted in the pelvis. The thickened gall-bladder, the large glands, and the condition of the pancreas seemed sufficient indication for cholecystectomy. Several of the large veins on each side of the pylorus were also ligated.

The patient recovered satisfactorily from the operation and returned home. Soon after his arrival there, however, he had two copious hemorrhages from the bowel and returned to the Clinic March 21, 1914. The hæmoglobin at this time was 40 per cent. and it was thought that either a small, actively bleeding ulcer had been overlooked, or that the varicose gastric veins in some way were responsible for the bleeding. These veins were a feature of unusual interest, for such extreme varicosity in this situation is rare, and it is important to note that fatal hæmatemesis has occurred in which no pathologic condition other than this could be demonstrated.

At the second operation, March 26, 1914, the pylorus was found bound down by adhesions, which were not separated. The varicose veins had become somewhat reduced in size since the former operation, and the pancreatitis was less evident. A posterior gastro-enterostomy was done on the assumption that the bleeding was due to erosions of the gastric mucous membrane.

Comparatively soon after this operation the patient began to show progressive improvement in the blood picture, and in November, 1914, his hæmoglobin and the red cells reached 84 per cent. and 4,680,000, respectively. At this time he consulted us in reference to an enlarged epididymis which was apparently tuberculous in character. December 7, a left epididymectomy with resection of the vas for tuberculous epididymis was done. His general condition was now so satisfactory that it was thought advisable to investigate the genito-urinary tract on account of the constant presence of blood-cells in the urine, the small

## SPLENECTOMY FOR GASTRO-INTESTINAL HEMORRHAGES

amount of pus, and the tuberculous epididymis. Cystoscopic examination showed the left kidney to be tuberculous and the right functioning well. On December 20, 1914, a left nephrectomy was done; the cortex of the kidney contained tuberculous abscesses.

After the nephrectomy his condition remained good until the following October (1915), when intestinal hemorrhages again occurred. There were no other symptoms except those directly incident to the bleeding. While under our observation he continued to pass black stools. On October 8, 1915, the hæmoglobin was 43 per cent. Various "remedies"—tannin, coagulin, emetin, irrigations of the stomach with hot water (130 degrees) through a tube—were tried with no relief, and on October 9 the patient was again explored.

Extensive adhesions were met with through the upper abdomen. A thickening on the anterior aspect of the gastric side of the gastrojejunal opening was found which was looked upon at the time as an ulcer. This was excised with the Paquelin cautery and closed by suture. Very free bleeding occurred during the closure of the opening. It was hoped that this area had been responsible for the recurrence of the bleeding. The patient did well for a few days and then began to vomit bile. This was not corrected by repeated gastric lavage and the condition finally became so critical that an entero-anastomosis between the two loops of intestine was necessary. This was combined with a jejunostomy with a catheter to be utilized for auxiliary feeding. The patient recovered from this procedure and went home in fair condition.

He returned to the Clinic three months later (December, 1915), reporting that he had passed a quantity of dark blood on two occasions during the previous week, and for the first time had vomited a small quantity of blood the day before he returned. Examination of the blood showed the hæmoglobin to be 35 per cent. He was kept under observation. The hemorrhages continued in spite of measures used to control them, and by January, 1916, the hæmoglobin had dropped to 28 per cent. with about 3,000,000 red cells, and every stool examination showed blood.

The persistency of the hemorrhages and the fact that by reason of the results of splenectomy, the spleen has been proved responsible for certain types of anæmia associated with hemorrhages of the mucous membrane, led to the consideration of splenectomy, although no enlargement of the spleen had been noted previously. On February 1, therefore, the patient was again explored through a left rectus incision and the spleen, which had been questionably palpable at the costal margin previous to operation, was found to

be twice normal size, its weight being 285 Gm. Although the liver was not distinctly cirrhotic, an "apparently moderate cirrhosis" was noted. Splenectomy was not particularly difficult, but as the patient was in very poor condition as a result of the repeated hemorrhages (he vomited blood on the operating table) it was of grave risk.

Recovery following removal of the spleen was necessarily slow; nevertheless it was steady and at the present time, seven months after the operation, the patient is in better health than he has ever been. He weighs 200 pounds; has had no sign of bleeding since the spleen was removed, and it is confidently expected that there will be no recurrence of the hemorrhages.

The difficulty in the correct interpretation of gastro-intestinal hemorrhages is recognized by many careful observers. Preble estimates that in two-thirds of such cases a diagnosis of the cause of the hemorrhages cannot be made. In this instance, the absence of an alcoholic history with the long-standing indigestion supported the erroneous diagnosis of duodenal ulcer. Aside from lesions of the stomach or intestinal tract, the most frequent cause of gastro-intestinal hemorrhages is splenic anæmia or primary hepatic cirrhosis. Unfortunately the clinical features and the operative findings cannot be looked upon as sufficient to make a positive diagnosis of either of these conditions. It is true, however, that the prominent symptoms in this case show a striking similarity to those which have been attributed by writers as characteristic of unrecognized or "latent cirrhosis." Preble and others have reported fatal gastro-intestinal hemorrhages associated with unsuspected cirrhosis and Armstrong describes a case in which the necropsy disclosed no pathologic changes.

The prompt arrest of the bleeding following removal of the spleen at least suggests that the spleen, either directly by some toxic influence or through the medium of the liver, was responsible for the hemorrhages. The patient (who, by the way, contributed much to the satisfactory result by most intelligent coöperation) had observed that in the later months of his illness, as soon as the hæmoglobin had reached about 45 per cent., intestinal hemorrhages invariably occurred, showing that even during periods of freedom from bleeding, the tendency to bleed was always present.

Aside from the interest centered in the diagnostic problem, observations of distinct importance may be made. The inadvisability and the futility of gastro-enterostomy, unless an ulcer can be seen or palpated, has long been noted by various observers, but some cases have been reported in which "erosions" have been found at operation

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and in which good results have followed gastro-enterostomy. It is quite possible that in some cases of gastro-intestinal hemorrhage demonstrable erosions of the mucous membrane may be present. Armstrong reports a satisfactory result following the searing of such a surface in the gastric mucosa, with a Paquelin cautery. These erosions are in all probability "toxic" in character.

On the other hand, the hemorrhages occurring in the cirrhosis, as far as I can determine, have never been associated with actual erosions, but have depended rather on changes in the blood-vessels and a low fibrinogen content of the blood (Whipple). This instability of the blood-vessels is shown in the tendency to petechial hemorrhages and the oozing from lips, gums, lungs and even ears in cirrhosis. In this case, although no definite destruction of mucous membrane was demonstrated, C. H. Mayo called attention to the highly congested mucous membrane which bled at the slightest touch. Taylor reports the case of a patient dying from a hemorrhage ten weeks following gastro-enterostomy for supposed ulcer, the necropsy revealing a marked hepatic cirrhosis.

There is an excellent illustration of the efficiency of an entero-anastomosis as a relief for bile vomiting due to an imperfectly functioning gastro-enterostomy. Most important, however, is the lesson that in every case of anæmia, and particularly when the cause of the anæmia is not obvious, the spleen should be considered, and should be explored when an opportunity is offered. Similarly, in cases in which gastro-intestinal hemorrhages are the predominating symptoms and no ulcer can be demonstrated, the liver also should be carefully inspected and a section excised for immediate microscopic examination.

Although such gastro-intestinal hemorrhages have been usually attributed to an hepatic cirrhosis, recent developments in surgery of the spleen provide a formidable array of facts to throw considerable doubt on the assumption that the liver is the only factor in these cases. Chauffard was one of the first to point out the possibility in some cases that cirrhosis is secondary to processes originating, or at any rate most marked, in the spleen. The many evidences, both clinical and experimental, of the intimate relationship of spleen and liver; the excellent results following splenectomy in splenic anæmia (a disease which is characterized by a tendency to develop cirrhotic changes in the liver, and by gastro-intestinal hemorrhages); the fact that gastro-intestinal hemorrhage has been reported as being associated with a "latent" cirrhosis but in which the most marked finding was an hypertrophied spleen; and last, the results of splenectomy in various blood diseases



are facts which give much prominence to the splenic factor in these obscure blood dyscrasies.

It would appear, therefore, that the result of the splenectomy herein reported opens up a wide and inviting field for investigation.

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## ENTEROSTOMY FOR ILEUS\*

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IN the last two years, at least seventeen articles dealing with intestinal obstruction, or ileus, have appeared, or have been extensively reviewed, in the larger American and English surgical and medical journals. Ten of these have been based upon clinical study, some of them analyzing long series of cases, and giving guides for diagnosis and treatment. Seven of them have been based upon laboratory study, with special endeavor to determine the nature and peculiarities of the toxic substances which are developed when the intestines are occluded. This large amount of thought and study indicates the present importance of the subject.

*Type of Cases.*—A very large part of the clinical study has dealt with the sequelæ and complications of appendicitis, but inflammations of the pelvic organs, other forms of intra-abdominal inflammation, and strangulated hernias have also contributed their share of obstructions.

One may see and operate upon scores of cases of appendicitis and other abdominal lesions, and not find among them a single serious intestinal obstruction, and all surgeons aim to use technic which guards against the development of such complication. But, on the other hand, in spite of skill and care, one may find patients whose lives will be sacrificed unless obstruction is relieved by operation.

The post-operative problems are the most puzzling. Peritonitis is present at the time of the operation. During the few days which follow, it has usually been so controlled that no harm results, but occasionally abdominal distention and constipation persist, pain and vomiting appear, and the patient's condition becomes serious.

*Pathology.*—Under these conditions the surgeon must decide whether the prime factor is peritonitis or mechanical obstruction. There are really three elements to consider: (1) Mechanical ileus; (2) paralytic ileus; (3) peritonitis.

In the articles above referred to, the belief in mechanical ileus is much more pronounced than it would have been in a similar series of articles written ten or fifteen years ago. During this period, the methods of preventing peritonitis have improved, the number of ab-

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\* Read before the New York Surgical Society, October 11, 1916.

dominal operations has increased; secondary operations, before terminal peritonitis is established, have become more common; and animal experiments have shown the marvellous power of the toxins which develop within the occluded intestine, entirely independent of peritonitis; hence the mechanical element in these cases has become better understood.

McLean voices the opinion of many surgeons and laboratory workers when he says, "It is our opinion that many patients suffering from peritonitis and ileus die, not of the peritonitis but of the ileus."

In considering this subject, we must remember that Sweet, Draper, and Whipple and their coworkers have found that toxic substances develop in the occluded part of the duodenum of dogs so virulent that  $\frac{1}{10}$  Gm. will kill a fifteen pound dog within a few hours.

Paralytic ileus is not well understood, and we have no pre-operative method of distinguishing it from mechanical ileus. It frequently accompanies peritonitis, but sometimes, as in cases reported by J. E. Adams, seems to be caused by trauma. When the autonomic nervous system is better understood, a better knowledge of paralytic ileus may be obtained.

The distinction between mechanical ileus and advanced diffuse peritonitis is very important. The former can be relieved by a simple operation, while operation for the latter too often brings discredit upon surgery and disappointment to all concerned. This distinction is the more difficult because both elements are usually present. Intestine which is obstructed by adhesions, or which is held quiescent by paralysis, is prone to infection, while, on the other hand, infected intestine is likely to show adhesions and obstructive angulations.

*Symptoms.*—If a patient goes for several days after operation without symptoms of peritonitis, and then, in spite of medication, has obstipation, distention, vomiting, and perhaps visible peristalsis, and if the general depression and increase in temperature and pulse rate are not as marked as would be expected from diffuse peritonitis, we may believe that mechanical ileus is present, and operation should be done. If similar conditions arise, even without the preceding period of quiescence, the question of operation is still to be considered. Well-timed enterostomy in suitably selected cases relieves the intestine of its toxic substances and prevents the development of ungoverned peritonitis.

It is assumed that careful and persistent efforts at relief by non-operative measures are to be used before operation is resorted to. Dr. Gibson presented this phase of the subject to the Society, last

year, and emphasized the value of pituitrin in this treatment. It is to be remembered that most patients will recover without operation if suitable enemata and medication are used. This, however, does not detract from the necessity of operation for the few patients who do need it.

*Types of Operation.*—In the literature above referred to, the following methods of operation are given: (1) Separation, or division, of adhesions or obstructive bands; (2) enterostomy; (3) anastomosis around the obstructed part of intestine, without resection; (4) resection, with immediate anastomosis (one-stage operation); (5) resection, with immediate artificial anus, and, later, anastomosis (two-stage operation); (6) various combinations of these procedures.

Of these procedures, the division of obstructive bands, or adhesions, is of course to be preferred, and is to be done whenever such bands or adhesions are the apparent cause of the obstruction. If there is distended gut above such obstruction and collapsed gut below it, the indication is of course manifest.

The occasions for the more extensive operations do not often come in the acute cases which we are considering. When they do come, gangrenous intestine or cancer usually gives the indication, and the resection is to be carried out on well-recognized surgical principles.

Our main attention may therefore be given to those cases for whom enterostomy is indicated.

*Enterostomy and Its Sequelæ.*—The operation of enterostomy is a very old one, and has been in use, at least, one hundred and twenty-nine years, since Renault's time. It is resorted to now much more frequently than it used to be. The details of the procedure differ with the case. Sometimes, without anæsthesia, a little opening is made in a loop of intestine which presents in the drainage wound; sometimes, under local anæsthesia, a small abdominal incision is made, a catheter, or small tube, is tied or stitched into an opening in the intestine, and a few Lembert stitches secure the intestines to the abdominal wall; sometimes, under general anæsthesia, a search is made for a definite obstruction, and failing to find this, an enterostomy opening is made with careful provision for the subsequent closing of the wound.<sup>1</sup> Sometimes, at the termination of a primary operation in unfavorable cases, an enterostomy is done as a safeguard. In all instances, the stoma should be as small as will be efficient.

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<sup>1</sup> As brought out by Dr. Lilienthal in the discussion of the paper "A Catheter Inserted According to Witzel's Gastrostomy Method Has Many Advantages."

Nothing in surgery is more dramatic than the improvement which comes from fortunate enterostomy. A patient who is almost moribund before the procedure is, a few hours later, comfortable, bright, and hungry. The change seems little short of miraculous. But, although the immediate improvement is so marked, the patient is not yet well. The original cause of obstruction is still to be dealt with, and the enterostomy opening is yet to be closed. The obstruction is frequently temporary. If there are many angulations in a moderately inflamed intestine, the total obstruction may be sufficient to produce stasis. Such obstruction, however, ceases if the distention can be relieved, and if the inflammation subsides.

A temporary disturbance of the sympathetic nervous system may, also, be a factor. The term "paralytic ileus," little understood but frequently used, indicates a belief in such disturbance. This, too, is believed to be temporary. Since the inflammation, a portion, at least, of the inflammatory exudate and the paralysis all tend to subside when the distention is lessened, it is evident that enterostomy will permanently relieve the obstruction in many instances. In other instances, however, the obstruction must be relieved by a second operation. The division of adhesive bands, or the resection of portions of intestine, are to be done according to the indications found at that operation.

*The Care and Subsequent Closure of the Enterostomy Opening.*—The subsequent behavior of the wound depends upon its structure and upon its site. If it is so constructed that there is sufficient serous or muscular tissue between the intestinal mucous membrane and the skin, and if there is no spur between the afferent and efferent loops, spontaneous closure is likely to result. If the opening is below the ileocæcal valve, the fecal discharge causes very little skin irritation; if it is much above it, there is apt to be more or less digestion of the skin by intestinal fluids, and a most annoying condition results. The skin may be raw for a wide area about the stoma, causing great discomfort and pain. In addition to this, there may be serious inanition. This condition is not common, but it occasionally occurs and is most pitiable. Handly has been so impressed with it as to describe the procedure as barbarous, and to advocate the more dangerous operation of ileocolostomy instead. One purpose of this paper is to describe a method of preventing this condition.

The suggestion came from seeing an obturator which Dr. S. W. Pallister, of Brooklyn, had used. In working over the subject, it was found that if a flat piece of wood, or similar hard substance, was held firmly against the intestinal opening from within, fecal leakage

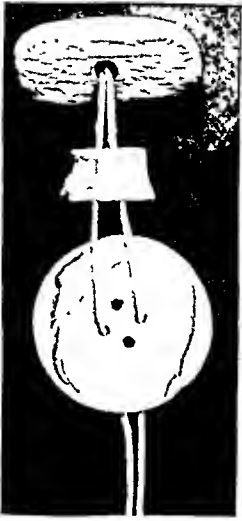


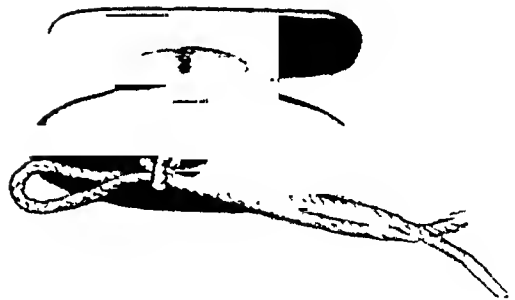
FIG. 2.—Same obturator closed.

FIG. 1.—Easily constructed obturator for preventing leakage from enterostomy opening made from button-mould, spool shank and button.

FIG. 3.



FIG. 4.



FIGS. 3 and 4.—Better finished obturator constructed by instrument maker.



would almost cease. After working over various models, I found that a button-mould, a button, and the shank of an ordinary sewing-thread spool make a very efficient and easily constructed apparatus. It may be used until the more finished model is obtained from the instrument maker or until the stoma is closed by operation. Figs. 1-4 explain the apparatus.

The inner disc, oblong in shape, is pushed through the stoma lengthwise. It should be large enough to occlude the stoma when pulled flatly against it. The shank should fit the stoma, and should be adjusted to the thickness of the abdominal wall. A knot larger than the hole in the inner disc is tied in the middle of a piece of string, the free ends are then passed through the inner disc, the shank, and the two holes in the outer disc, or button. With the string slackened, the inner disc is inserted through the stoma. The string is then tightened and tied firmly, thus fixing the appliance into the shape of a collar button, with one flange inside the intestine and the other flange outside the skin. The intestinal leakage is thus stopped, the skin irritation disappears, and the patient's nutrition improves.

In one instance, in the writer's experience, the result of this procedure was apparently life-saving. A young man whose emaciation was extreme, and whose abdominal skin was raw over a very large area, promptly became comfortable and well-nourished, and a successful closure of the stoma by suture was soon possible.

With this resource, one may more often do enterostomy for the severe forms of ileus, feeling confident that those patients who make immediate recovery will not have distressing convalescence.

*The closure of the enterostomy opening* occurs spontaneously in many cases. Most of the remaining cases may be easily closed by operation.

Beer and Coffey have each described excellent methods of closing the stomas by simple operations which are almost devoid of danger. The essential steps are three: (1) Closure of the intestinal opening; (2) support of the suture line by firm or fatty tissue; (3) provision for drainage at a distance from the suture line. They give excellent plates to illustrate their methods.

My own operations have been based on these principles: The intestine has been loosened from its adhesions to the abdominal wall, but a very wide exposure of the peritoneum has been avoided. Through-and-through stitches have then inverted the edges of the intestinal stoma; Lembert stitches have reënforced the suture line, and almost



complete closure of the abdominal wall, in layers, has followed. This closure has not been absolutely complete, as provision has always been made for drainage at a little distance from the intestinal sutures.

Intestinal resection is a severe operation, and is to be avoided when possible. Coffey quotes Makins, Bryant, and Tillman as giving a mortality rate for this procedure of  $38\frac{4}{10}\%$  to 27%. To-day's statistics would probably show a lower rate than this, but, at best, the operation is much more severe than the simpler one described above, and is to be avoided whenever possible.

CASE I (Roosevelt Hospital).—A-7182. I. S., aged seventeen. Appendectomy January 16, 1916, for gangrenous appendicitis. Much foul-smelling pus present. He did reasonably well, but, January 31, had developed symptoms of intestinal obstruction which were very threatening. His temperature was  $102^{\circ}$ , pulse 132, respiration 28, white blood-cells 23,800, polymorphonuclears, 78 per cent., obstipation in spite of enemata, pituitrin, and other medication. He had marked abdominal distention, vomiting, and visible peristalsis. Incision was made through the right rectus in the hope of relieving the obstruction. The small intestines were distended and red. There was considerable free fluid in the abdominal cavity. The large intestine was not distended. The maximum of inflammation was in the pelvis. The adhesions were broken up, gas was pushed from one loop to another, cigarette drains were put into the pelvis, and the abdomen was closed without enterostomy in the hope that the obstruction had been relieved. The following day, however, no relief had come, and the patient was in a desperate condition. Temperature  $103.6^{\circ}$ , pulse 144. A small opening was made in the lower part of incision, the protruding loop of intestine was opened, and a Paul tube inserted. Considerable fecal matter and gas passed through this. The next morning his distressing symptoms had disappeared, his pulse was much better, his temperature was  $98.8^{\circ}$  and he was asking for food. He progressed favorably for about ten days, but by that time showed inanition from the leakage of intestinal contents. The abdominal wall was much digested, raw, and tender. After consultation with Dr. Julius Weinstein, various kinds of diet were used and various methods of dressing, but the patient's condition was still critical, and his emaciation extreme. A wooden button was then inserted into the enterostomy opening and made fast. The leakage almost ceased, the raw condition of the abdomen quickly improved, and by the first of April we were able to close the wound by

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means of inner stitches through all the coats of intestine, reënforced by Lembert stitches, and further protected by abdominal wall which were sewed in layers in front of them, leaving a little loose spot for the emergence of the discharge, if any should occur. On May 15, when the patient left the hospital in good condition, this had closed to a pin-sized opening, and it completely closed soon afterward.

CASE II (Roosevelt Hospital).—A-7128, S. G., aged 14, April 5, 1916. Two years previously, in another city, ileus occurred three weeks after an operation for appendicitis with abscess. Ileostomy done. He had worn obturators diminishing in size from time to time, ever since. Stoma closed by operation April 5. Intestine freed from its attachment to abdominal wall. Intestinal edges inverted by through-and-through stitches. Suture lines reënforced by Lembert stitches. Abdominal wall almost closed over them. No intestinal leakage. Left hospital twenty-five days later with wound almost healed. Complete healing two weeks later.

CASE III (Roosevelt Hospital).—A-7227. Mrs. N. D., February 10, 1916. Came to hospital with symptoms of intestinal obstruction. Constipation complete. Vomiting, distention, visible peristalsis. The large intestine was distended up to the splenic flexure, and flat beyond. No definite band or growth could be found in that place, but after manipulation the gas passed through into the descending colon, and the wound was closed. Patient did well for three weeks, then symptoms recurred. An enterostomy was done at the caput coli. Entire relief of symptoms. Button worn for considerable time to control intestinal discharge. Movements by rectum followed this. She finally left the hospital without further operation, with the stoma still open, expecting to have this closed at a later time.

CASE IV (Roosevelt Hospital).—A-7987. W. S., aged seventy. September 20, 1916. Extreme vomiting, distention of colon and small intestine. Patient in condition of profound depression. Symptoms had been recurring for several months. X-ray had indicated obstruction in hepatic flexure of an enormously distended colon. Enterostomy at the caput coli done as emergency life-saving procedure. Rapid gain in strength. Obturator introduced one week later nearly controlled the fecal leakage. Worn a few days, was then removed to allow the muscular part of the incision to heal more firmly before further surgical procedure. Patient now wearing obturator, and having stools per ano.

CASE V (Roosevelt Hospital).—A-5698. W. W., aged twenty-eight. December 12, 1915. Patient came to the hospital

with a prolapse of the colon through a colostomy wound in the transverse colon, which had been opened through an incision in the left rectus. His rectum had been excised in another city. The colostomy wound in the left inguinal region had later become obstructed, and, in an emergency, a colostomy had been done in the transverse colon to relieve the obstruction. The portion of the transverse colon above this opening had become so prolapsed that about six inches of the intestine hung down through the opening. The first operation, December 15, 1915, reestablished the left inguinal colostomy; the second operation, January 3, 1916, united the walls of the stoma in the transverse colon by through-and-through stitches of catgut, reënforced by Lembert stitches and further strengthened by partial closure of the abdominal wall. Healing was not satisfactory after this operation, and, on January 21, a clamp was put on the spur of intestine. On February 14, the edges of intestine were brought together as at the time of the first operation, and healing was easily obtained. Patient left the hospital on March 9, in excellent condition and with his wound healed.

CASE VI (Roosevelt Hospital).—A-6340. Mrs. B. H., aged thirty-nine. Discharged August 15, 1915. June 19, 1915, Mikulicz's operation for recurrent carcinoma of descending colon. July 27, the opening in the intestines was closed with catgut stitches taken through all the coats. This repair was then reënforced by Lembert stitches of chromic gut. The layers of the abdominal wall were then fastened together, excepting for a very small area which provided for possible drainage from the suture line. Patient left the hospital August 15 with stoma closed.

CASE VII (Roosevelt Hospital).—B-3291. C. A., male, aged sixty-five. September 13, 1912. Patient had an artificial anus in the descending colon, the result of a partial colectomy for diverticulitis. Both afferent and efferent portions of intestine were left in the wound, and the spur between the two had been divided by a clamp. October 13, an incision was made around the fistulous opening liberating the intestines for about one inch from stoma. Catgut stitches were taken through all coats of intestines to close the stoma, and these were reënforced by several Lembert stitches. The layers of abdominal wall were sutured together, excepting for a very small opening to provide drainage from the intestinal suture. Much improvement was obtained by this procedure, but there was still a slight fistula on November 3, which

was closed by a similar operation. The patient left the hospital on December 14, with the wound entirely closed.

CASE VIII.—Boy of twelve. Seen in consultation with Drs. Tilton, Brewer, and Peck, December, 1912. Appendicitis, with abscess formation and peritonitis, followed by post-operative ileus. Secondary operation revealed an obstructive kink in the lower ileum. Temporary improvement followed the relief of this obstruction, but the next day the condition became desperate and, as an emergency procedure, an opening was made in a loop of intestine which presented at the drainage wound. Gas escaped, and at a later time intestinal contents escaped in large amount. This was finally controlled by a flanged catheter. The wound closed spontaneously and recovery followed.

CASE IX (Roosevelt Hospital).—L. D., aged fifty. August, 1913. Six days after a gastro-enterostomy, he developed symptoms of ileus. Vomiting was persistent, and finally had a fecaloid odor. The constipation was complete. Had much distention, and an incision was made in the median line to find the point of obstruction. The small intestine was much distended. The lower part of the large intestine was not distended. No definite point of obstruction could be found. An enterostomy was done in the ascending colon. A large amount of gas escaped. Wound was kept open for three or four weeks, and then closed spontaneously. Complete recovery.

CASE X (General Memorial Hospital).—G. S., aged eighteen. February, 1912. Appendicectomy. Eight days later, ileus, followed by spontaneous rupture of the intestine into the drainage wound. Immediate relief of symptoms. Fecal drainage. Spontaneous closure of fistula. Complete recovery.

CASE XI (General Memorial Hospital).—November, 1912. Operation for abdominal abscess of uncertain origin. Post-operative symptoms of localized peritonitis and intestinal obstruction very severe. Spontaneous rupture of intestine into drainage wound. Prompt recovery, with spontaneous closure of fistula.

CASE XII (General Memorial Hospital).—H. C., woman of forty. October, 1906. The intestinal fistula had been present for several years following an operation in another city. This was closed easily by liberating the intestine, sewing the edges together, reënforcing suture line with Lembert stitches, and supporting this by the abdominal wall sewn in layers.

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# TEMPORARY COLOSTOMY

A PRELIMINARY REPORT UPON A NEW TECHNIC

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As a foreword, the writers of this article wish to state that the primary purpose of submitting the following technic at this time is with the hope that the same will be critically reviewed by surgeons whose opportunities in the greater clinics will enable them to prove the practical worth, either pro or con, of this technic, should the following report with the results of animal experimentation appeal sufficiently to their surgical judgment.

Earlier diagnosis, better understanding of the anatomy (especially of the lymphatics), and improved surgical technic have caused almost total substitution of temporary colostomy plus radical extirpation for permanent colostomy in malignancy of the pelvic colon or rectum. In the writers' experiences, the safe and early closure of the artificial stoma, after it has ceased to perform a useful function, has often presented a more complex, discouraging and dangerous problem than the primary operative procedure.

In the performance of a temporary colostomy the primal considerations are:

1. *Speed*.—This is essential in any operative procedure, but here we are usually dealing with a patient who is far below the average as a surgical risk and consequently speed may spell the difference between life and death.

2. *Protection of the General Peritoneal Cavity*.—It is to be remembered that we are dealing with the most septic portion of the alimentary canal under normal circumstances, which under the usual circumstances calling for colostomy has become a culture tube "par excellence" whose bacterial content has been infinitely multiplied. (This is one of the chief objections to the immediate use of Paul's tube, Collier's apparatus, etc.) In addition to the dangers of sepsis, we have the possible added dangers of cancer cell implantation under certain circumstances.

3. *Prevention of Mucous Eversion.*—This is one of the *chief* factors which retard spontaneous closure of our stoma and is productive of persistent fecal fistula, often more formidable to deal with than the original lesion.

4. *Prevention of herniation and sacculation of the proximal gut.*

5. *Ability to Close the Stoma Soon After it Has Ceased to Perform a Useful Function.*—The ideal would be, of course, to be able to spontaneously close the stoma at approximately a given time.

6. *Conservation of the intestinal lumen* to insure an absence of stenosing injury and its future functional integrity.

7. *To establish an efficient stoma.*

To accomplish the above, there have been innumerable operative procedures and mechanical devices suggested, requiring operation in one, two or even three stages. The writers of this paper believe they



**Fig. I**

have devised a technic that covers the seven basic requirements as enumerated above, in one stage. The technic is as follows:

Incision, exploration, etc., are just the same as any type. Choice of dealing with the gut, *i.e.*, single-barrelled, double-barrelled or simple attachment of the gut to the peritoneum, is simply a matter of judgment; after such decision we next grasp the gut with a crushing clamp, as per cut Fig. 1, *A, B, C*, according to the type. Within the bite of the crushing forceps is interposed a piece of dentist's rubber dam, the same width as the proposed stoma and about four inches long. The parietal peritoneum is carefully circumstitched around the gut, keeping in mind the longer time the necessity of a functioning stoma is



FIG. 2.—Here a Pyor clamp (*E*) (if not convenient, use any form of crushing forceps, preferably with a narrow blade) is applied to the antimesenteric border of the gut, just engaging sufficient gut to insure an ample stoma, avoiding the useless waste of tissue; the forceps engage the gut about one-eighth of an inch longer than the proposed stoma. The rubber tissue (*C*) is cut the exact width of the proposed stoma (the ideal substance is a piece of medium-weight dentist's rubber dam, but if not at hand the wrist portion of an old rubber glove will serve). The gut is picked up at two points, with either Allis or hæmostatic (*A* and *B*) forceps which are held slightly apart by an assistant while the operator applies the crushing forceps with the rubber tissue within the bite.



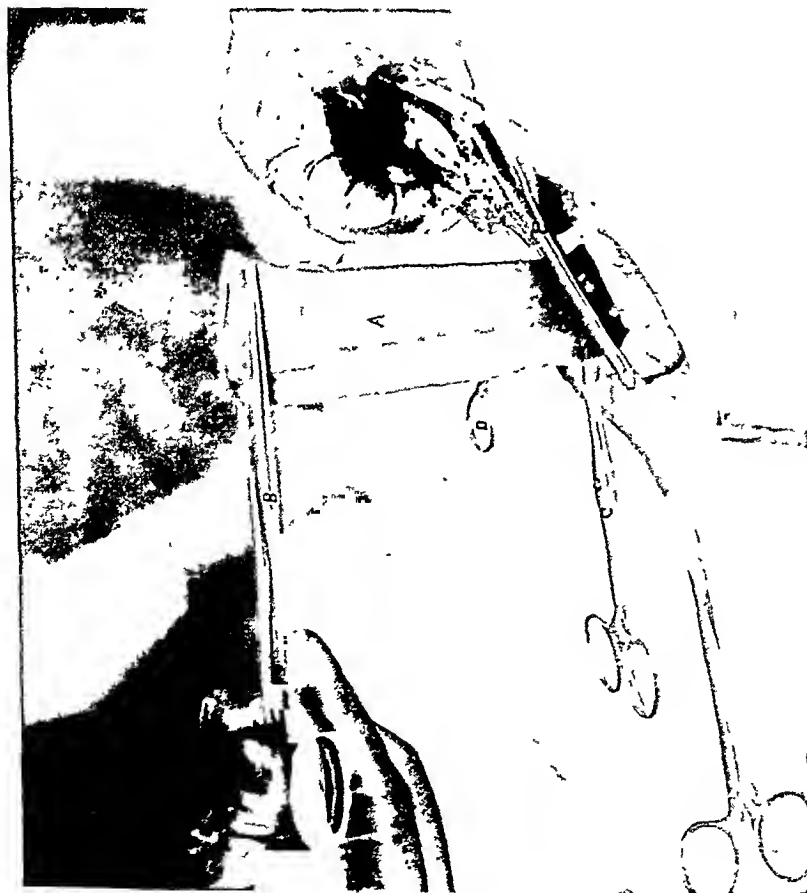


FIG. 3.—This gives a somewhat better view of the rubber tissue (A) which is interposed to prevent serous union. Notice the excess that is below the bite of the clamp (E); this is trimmed off in the manner illustrated in Fig. 4. It is a waste of time to attempt to apply the clamp just flush with the rubber, as it can be snipped off in the manner illustrated in less time than it takes to tell of the same.



FIG. 4.—Here the excess of rubber tissue, as shown in Fig. 3, is being trimmed away. Take hold of each end of the excess with a hemostat (1, B), draw taut and elip with scissors (C); by drawing taut the same will contract almost flush with the clamp, as per illustration.

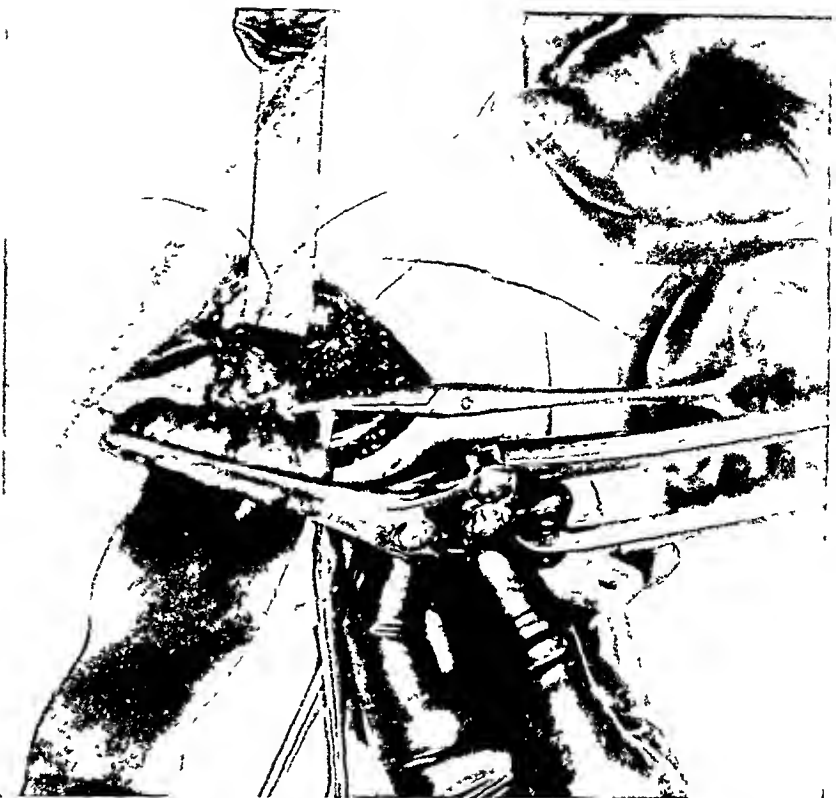


FIG. 5.—Sewing the visceral to the parietal peritoneum. The level at which this is done depends upon the type of colostomy and the length of time you propose to allow the new stoma to functionate, *i.e.*, in a simple temporary colostomy with an estimation of about two weeks desirable functionation, you would sew your visceral and parietal peritoneum close to the clamp, leaving just face enough to apply the Kerr basting stitch. In one where the stoma was to be permanent, or one which was to usefully functionate over a long period, you would suture your parietal to visceral peritoneum at a sufficient distance from the forepops to bring your new stoma upon a level with the skin. The question of the desirability or non-desirability of a spur formation would be guided by the operative indications as in any method.



FIG. 6.—Cutting away the gut above the bite of the crushing clamp. First draw the rubber taut to one side and grasp the portion of gut above the crushing clamp (A) with a second clamp (B) parallel with first one (to prevent leakage). Cut with a sharp knife between the two clamps, cutting away from the rubber tissue so as not to cut the same. After the gut is severed thoroughly, cauterize with carbolic acid, wipe with sponge but do not follow with alcohol.



FIG. 7.—Applying Kerr basting stitch. Apply in the same manner just as though the rubber were not interposed, passing back and forth, piercing the rubber with each stitch; this holds the rubber *in situ*. (For the technic of the stitch I refer the reader to "Basting Stitch," etc., by Kerr, of Washington, D. C., published in *Surg., Gynec. and Obst.*, October, 1913.) Use a curved needle and fairly heavy Pagenstecher. Note the approximation of visceral and parietal peritoneum with small stitches to insure accurate and tight approximation with early union and consequent safety.



FIG. 8.—The two ends of the Kerr stitch (A and B) are now pulled taut, which causes the complete infolding of the intestinal wall, leaving the rubber tissue interposed to prevent union of the scrotal surfaces. The two ends of the Kerr stitch are then passed through the entire thickness of the abdominal parietes from within outward, emerging just above and below the upper and lower angles of the wound.

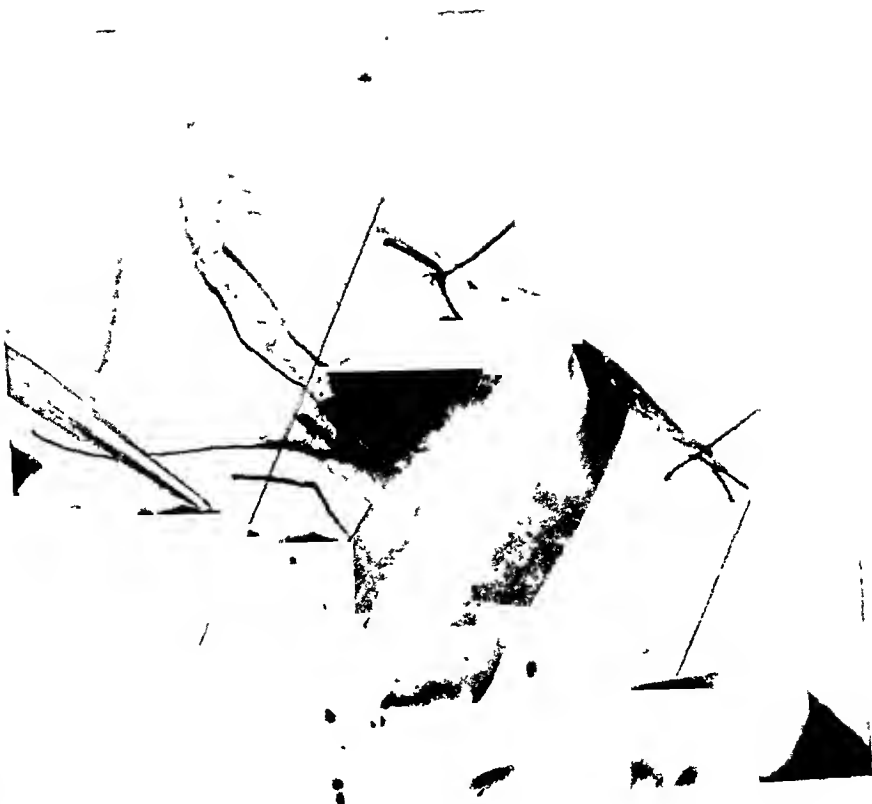


FIG. 9.—The wound is then closed by one silkworm-gut suture above and one below the interposed rubber. The rubber prevents union of the parietes and obviates the necessity of vaseline gauze, etc. It also makes a pathway of least resistance for any possible leakage or infection, i.e., acts as a drain.



FIG. 10.—Next the excess of rubber is rolled flat between gauze and the Pagenstecher ends (A and B) of the Kerr suture are tied fairly snug over another piece of gauze laid over the infolded rubber. Then apply the usual laparotomy dressings.



## TEMPORARY COLOSTOMY

anticipated, the further away from the crushing forceps the gut is to be circumstitched. Next apply another crushing forceps parallel and distal to the first, then cut between, cauterize with carbolic acid and apply a Kerr basting stitch, the ends of which are brought out through the abdominal wall and tied over gauze. This stitch is to be removed when necessity calls for a patent stoma.

At the end of thirty-six hours, union between the parietal and visceral peritoneum is complete and the basting stitch may be cut close to the skin on one end and pulled out at the other. (As a matter of fact, if you have been careful with the circumstitching of your gut and still leave your rubber *in situ* to act as a drain, the stitch may be taken out safely as early as twelve hours.) After the basting stitch has been removed, the rubber acts as a guide to the stoma, which sometimes remains sealed after the stitch is removed, due to the crushing of the forceps; the introduction of the gloved finger easily overcomes this. The subsequent treatment would be that following any type of colostomy, depending, of course, upon the individual case.

Animal experimentation with this technic has been carried out upon seventeen dogs, with two deaths, neither due in any way to the type of operative procedure. We varied our technic somewhat, but finally concluded the steps, as illustrated in Figs. 2-10, inclusive, to be the simplest, safest and most efficient.

The advantages of this technic are as follows:

1. There is no necessity for any secondary operative procedure to establish a patent stoma, either cutting or burning, both of which necessitate the bringing of gut to the surface, or at least well into the wound. Simply withdraw the basting stitch.

2. The crushing forceps have obviated any possibility of hemorrhage from the gut.

3. The gut may be suspended at any height from the peritoneum to the skin, this governing the rapidity of the after closure.

4. The slight inversion of the serosa, produced by the Kerr suture, has a tendency to remain so after the stitch is withdrawn, due to the serous union at each extremity of the opening caused by the longitudinal initial and terminal stitch of the Kerr suture and to union of the serosa to the parietes. This inversion has the tendency to prevent a mucous eversion and consequently slow healing fistula.

5. The interposed rubber obviates the necessity of any packing with other rubber tissue or vaselined gauze and acts as a drain in case of infection or possible leakage. It also acts as a guide to our newly-formed stoma.

6. The most rigid conservation of intestinal tissue insuring against crippling defects; this is markedly true where the stoma is placed deep.

ILLUSTRATIVE CASE.—Mr. H. A. H., aged sixty-four years, referred by Dr. Richard H. Lion, of Bothel, Washington, operated upon at Providence Hospital, August 26, 1916; *permanent colostomy for inoperable carcinoma of the pelvic colon*. The technic described in the previous pages was employed. The patient left the hospital on the twelfth day and his post-operative convalescence was no more stormy than that of a simple appendectomy. The result was ideal.

# FIBROMA OF THE SMALL INTESTINE RESULTING IN INTUSSUSCEPTION

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AND

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OF PHILADELPHIA

THE purpose of this paper is to contribute a case-report of a fibroma of the small intestine, to emphasize the relation between benign tumors of the intestine and intussusception in adults and to comment briefly on the rarity and collected cases of intestinal fibroma.

Miss A. J., aged thirty-four, stenographer. General appearance of under-nutrition; average weight, 114 pounds. No important infectious features in family or previous personal history.

The patient was first seen in consultation with Dr. Wm. R. Williams, April 20, 1915. Paramount in the history obtained at this time was the severe pre-menstrual pain and the cramps during the first day of each menstrual period; this dysmenorrhœa having become progressively worse, especially within the past six months. Two days prior to the present illness, menstruation had appeared, at the regular time and with the usual degree of distress; the patient being relieved the following day with the full establishment of the flow.

On the morning of April 20, the patient went to her office, but immediately upon arrival was seized with an attack of intense abdominal pain, accompanied by faintness, nausea and weakness. Upon her return home, there were evidences of a mild degree of shock with, at first, a weak, slow pulse, slightly subnormal temperature, pallid face and tender and rigid abdomen. Because of the menstrual history, some pelvic condition was suspected.

Examination, made three hours after the initial attack, revealed a tense abdomen, generalized tenderness, marked rigidity but no distention. The temperature was normal, pulse 90, regular and strong. Pelvic investigation was difficult; a small anteflexed uterus could be outlined in an anterior position; the adnexa were not distinctly palpable; there was no lateral tenderness or enlargement. There were no gastric symptoms present and an enema just prior to the examination had secured an apparently normal evacuation. There were the physical signs of a mitral stenosis, but the patient had not suffered symptomatically from it.



A tentative diagnosis of ovarian cyst twisted upon a pedicle was made and the hospital advised. Upon admission to the Hahne-mann Hospital in the early evening, the temperature was 99.4° F., pulse 72, the pain decidedly lessened and the abdomen less tender and rigid. There was no nausea or vomiting. With this improvement, operative interference was postponed. During the night the patient was comfortable without narcotics and took small quantities of liquids without distress. Toward morning, there was some hiccoughing. In the early morning, hiccoughing was pronounced and there was increasing rigidity of the abdomen with beginning distention. Temperature was 98.2° F., pulse 84. Immediate operation was approved.

The operative incision was in the midline below the umbilicus. Upon opening the peritoneum, there immediately protruded a number of distended, darkened coils of small intestines knotted together in a cluster or mass, at the base of which the omentum, twisted, formed a firm, tight, constriction band. To free these coils, it was necessary to incise the omental ring. This done and the "mass" separated, an intussusception of the ileum was noted. With careful traction, 55 cm. of gangrenous, foul, invaginated gut was withdrawn, and at the distal end of the released intestine a small, hard nodule was felt. Clamps were applied in suitable healthy areas at either end of the necrosed gut, inclusive of the nodule, and the part removed. The free ends of the gut were ligated, invaginated and closed with a purse-string suture. A lateral anastomosis was then made, the mesentery sutured and the abdomen closed without drainage.

Upon reaction, the patient was placed in the upright position and a continuous proctoclysis of normal saline solution begun. Hiccoughing persisted for the first two days with some nausea, slight distention and severe abdominal pain. Peristalsis was audible on the second day: the temperature was normal and the pulse rate 92 on the third day. On the fifth day, a low enema was given and fecal matter and considerable flatus obtained. The abdominal wound healed by primary union and the patient was allowed to sit up on the fourteenth day. Two days later, a mild phlebitis involving the left leg developed. The case was discharged from the hospital thirty-four days after operation.

Subsequent to operation and in the light of its findings the patient was further interrogated regarding her history. It was elicited that constipation had been increasing in severity for the past four years. During this time, there were attacks of malaise, a "general sick feeling," and some indefinite abdominal distress not relieved by bowel evacuation. For the last three months, the constipation had been exceedingly distressing and accompanied by

## FIBROMA OF THE SMALL INTESTINE

loss in weight. Occasionally, the patient had noticed bright blood in the stool, but attributed it to hemorrhoids.

Eighteen months after operation, the patient is up and about but in somewhat delicate general health. Her abdominal condition, however, is excellent and she suffers no gastro-intestinal symptoms except constipation, which still persists but in lessened degree.

*Pathologic Examination.*—The specimen consists of 60 cm. of discolored, gangrenous small intestine with a small tumor a few centimetres from one of the resected ends. The tumor is a reddish, hard, smooth, roughly spheric nodule, projecting into and occupying a considerable portion of the lumen of the ileum from an attachment exactly opposite to that



FIG. 1.—Silhouettes of tumor and intestine (natural size).

of the mesentery. The growth measures  $2.4 \times 1.9 \times 1.9$  cm. and it attached by a broad base measuring 1.8 cm. (see Fig. 1).

Microscopically, the tumor is a hard fibroma arising from beneath the outer muscular layer of the gut and pushing the various coats before it in its projection into the intestinal lumen. Fasciculi of fibrous tissue run in all directions and blood-vessels are numerous. The muscular layer of the gut acts as a sort of a capsule to the tumor and above this is the necrotic and atrophied submucosa and mucosa, with only shadow effects of the normal cellular structure. There are numerous dilated capillaries in the mucosa and submucosa. Beyond a slight degree of hyalinization, there is no degeneration apparent in the tumor proper.

*Discussion.*—Malignant growths of the bowel become clinically apparent in many ways and only rarely through causing intussusception. On the other hand, benign tumors of the intestine attract attention almost solely through the intussusception which they induce. Excepting those growths of the rectum and sigmoid which may be seen or felt, they are for the most part clinically silent as far as suggestive symptoms are concerned. It is true they give rise to constipation and abdominal pain, but such symptoms are common to so many conditions as to be of no diagnostic significance. Bleeding is more suggestive but frequent and common to other lesions. It is also possible that the tumor may be felt through the abdomen as in Watson's<sup>1</sup> case or give rise to obstruction without intussusception as in Dewis's<sup>2</sup> and Fenger's<sup>3</sup> cases, but these findings are so rare as to be of little or no value.

The importance of the relation between intussusception and benign tumors of the intestine is seen in the fact that many cases are reported as intussusception rather than tumor; and even when the title head of a report reads tumor of the intestine it usually includes mention of intussusception. Kasemeyer,<sup>4</sup> in his exhaustive article on "Tumor Invagination of the Intestine," states that, in searching the literature, he was astonished at the large number of cases of intussusception due to tumor. That the vast majority of cases of intussusception is not due to tumor and that this vast majority occurs in infants and children is, of course, well known. But in subjects past seven years of age, tumors of the intestine are etiologic factors to be considered. Eliot and Corscaden<sup>5</sup> analyzed 300 cases of intussusception in adults and found 100 cases due to tumor. Stetten<sup>6</sup> states that in 60 per cent. of 67 cases of intestinal lipoma in which symptoms were present, an invagination existed. Kasemeyer collected 208 cases of invagination of the gut due to tumor. He reports altogether 284 cases, but 76 of these were not due to true tumors, 60, for example, arising from inverted appendices and diverticula.

Though malignant growths are very much more common than benign tumors of the intestine, the percentage of invaginations is higher in benign than in malignant neoplasms, showing conclusively the far greater tendency of benign tumors to induce intussusception. Of Eliot and Corscaden's 100 cases, 60 per cent. were benign and 40 per cent. malignant. Of Kasemeyer's 208 cases, 55.75 per cent. were benign. It is difficult to say whether one variety of benign tumor exhibits a greater tendency to induce invagination of the gut than another. It is much more likely a matter of the size, weight, situation and form of the tumor rather than the special variety. The tendency of benign internal intestinal tumors to grow in pedunculated or polypoid form is favorable

## FIBROMA OF THE SMALL INTESTINE

to the induction of intussusception in contrast with the infiltrating growth of malignant neoplasms.

Fibroma is one of the rarer benign neoplasms of the intestine. One finds isolated reports of angioma, lymphangio-endothelioma, lymphadenoma, papilloma and cyst, but of the relative common and important tumors such as fibroma, lipoma, myoma and adenoma, the fibroma is the least frequent. Dewis found only 5 fibromas in collecting 219 benign intestinal tumors. Adenomas, if one adds the polyps which are usually of adenomatous structure, are so common as to be seldom reported unless multiple and causing complications. Hake,<sup>7</sup> in 1912, collected 58 cases of intestinal myoma, adding 23 to Steiner's<sup>8</sup> 35 cases. Stetten, in 1909, collected 74 cases of the submucous or internal lipoma. We were able to find reports of 24 fibromas of the intestines.<sup>12-35</sup> Of these Dewis collected 4 and added one of his own. Eliot and Corscaden collected 11. Kasemeyer reports 8, but one of these, that of Greig Smith, was mentioned by Eliot and Corscaden. Means and Forman<sup>9</sup> report one of their own. And the one reported herewith makes the total 25. A number of cases listed as fibroma of the intestine do not qualify as such. Pantzer's<sup>10</sup> "Fibroma of the Intestine Eventuating in Intussusception and Obstruction" is not a fibroma at all, but a myoma, the only mention of fibroma being in the title. The report of Alexander<sup>11</sup> on "Intestinal Obstruction Due to Fibroma" is an account of a uterine fibromyoma and not an intestinal tumor. The "fibroma" of F. S. Watson mentioned in Means and Forman's paper is spoken of by Watson as a "fibro-adenoma of the inner wall of the ileum," but he states that the specimen was mislaid before a thorough histological examination could be made and so its nature is doubtful. In our list we have strictly excluded fibromyomas or myofibromas, classing them with the myomas. We have admitted myxofibroma and myxoma. We have also listed an adenofibroma and a pedunculated fibropapilloma which seemed to meet requirements. Our own case was a pure hard fibroma.

The results of operation in fibroma of the intestine are very encouraging, especially when it is considered that so many of the cases are complicated by intussusception and require resection. Of the 25 cases collected, 22 were operated and of these 16, or 72.7 per cent., recovered.

*Summary.*—A hard fibroma of the ileum causing intussusception and successfully operated with resection of the intestine is herewith reported. Benign neoplasms of the intestine are relatively frequent causes of intussusception in adults. The rarity of fibromas among the infrequent benign intestinal tumors is seen in the fact that the authors were able to collect only 25 cases. Of 22 cases operated, 72.7 per cent. recovered.

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# TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting, held November 6, 1916*

DR. GEORGE G. ROSS in the Chair

## GUNSHOT WOUND OF THE CAROTID ARTERY

DR. E. G. ALEXANDER narrated the history of a man, twenty-six years of age, who was admitted to the Episcopal Hospital, August 6, 1916, with a gunshot wound of the neck. The wound was on the right side of the neck, one and a half inches above the clavicle and one and a half inches to the right of the median line. There was a large swelling on the right side of the neck that extended from the clavicle almost to the angle of the jaw. The trachea was pushed over to the left and on a line with the angle of the jaw. There were periodic discharges of a considerable quantity of blood from the wound, and with each of these discharges the size of the swelling in the neck was appreciably diminished. The patient was slightly shocked, dyspnoic, cyanotic and emitting a frothy mucus from the mouth. He could only speak in a whisper. There was no wound of exit but the bullet could be felt subcutaneously to the right of the vertebral border of the left scapula and about on a line with the fourth rib.

The patient was immediately taken to the operating room and operated upon under ether anæsthesia plus the administration hypodermatically of morphine sulphate, grain  $\frac{1}{4}$ , and atropine sulphate grain  $\frac{1}{150}$ .

An incision was made along the anterior border of the sternocleidomastoid. The tissue was so infiltrated with blood that the usual landmarks of the neck could not be made out. The incision was deepened and immediately on opening the deep fascia blood gushed forth in a continuous stream. As the flow of blood was so profuse it was impossible to locate any structures or bleeding points. The wound was therefore rapidly enlarged down to the clavicle. Hæmostatic forceps were then thrust at random into the wound and clamped, gauze sponges were also packed into the wound. These two procedures controlled the bleeding to a certain extent. By rapidly removing the gauze packs and quickly inserting another the bleeding point was proved to be at the

lower angle of the wound underneath the clavicle. Long curved hæmostats were clamped in the wound underneath the clavicle where the bleeding seemed to be coming from. After several attempts the bleeding was controlled.

As the patient had lost a large quantity of blood his condition was most serious. An intravenous injection of normal salt solution and adrenalin was given.

As many hæmostats were clamped in the wound the next step consisted in removing as many as possible and ligating the bleeding points. Hæmostat after hæmostat was removed until only a few remained and these were over the line of the common carotid and innominate arteries. The tissues were then exposed and it was found that these arteries were clamped. The carotid was ligated and the hæmostats on it removed. There still remained three long curved hæmostats underneath the clavicle, and as it was impossible to pass a ligature around them it was decided to leave them as clamped. The intravenous injection failed to show any beneficial effects, as the patient was blanched and pulseless. It seemed as if he would die on the table. The officer who accidentally did the shooting was fortunately at hand, and after explaining the patient's condition to him he readily consented to give some of his blood. A transfusion of 750 c.c. was done by the Kempton-Brown method. The patient's condition immediately improved. He gained some color and it soon became possible to feel his pulse. The wound was closed with the three-curved hæmostats left *in situ*, supported by a small packing of gauze. The patient was sent to his bed greatly shocked.

*After operation* (August 6, 1916).—Patient greatly shocked. Recovered from ether quickly, complains of little pain, given stimulation and started on enteroclysis.

7.00 P.M.: Temperature 102, pulse 126, respirations 28. Pulse of much better quality. Given hypodermoclysis, one pint every six hours.

August 7, 1916: Kept mildly under the influence of morphine sulphate. Had a fair night. Can speak only in a whisper. Pulse rapid. Temperature 103.3. Takes enteroclysis poorly. Complains of intense thirst.

August 8, 1916: Temperature down, pulse better, respirations slower. Kept under the influence of morphine sulphate.

August 9, 1916: Given water by mouth, enteroclysis given intermittently. Lies quietly on back. Dressings, which were blood soaked, changed.

August 10, 1916: Temperature 99; pulse 100. Very quiet, lying on back. No pain. Condition satisfactory.

## GUNSHOT WOUND OF THE CAROTID ARTERY

August 13, 1916: Taken to operating room and hæmostats unclamped, but as bleeding began they were reclamped.

August 14, 1916: Has developed pain in the left chest, friction rub is heard.

August 16, 1916: Pleurisy better.

August 17, 1916: Taken to operating room and hæmostats unlocked, slight bleeding resulted. This was controlled by lightly packing the wound with gauze.

August 21, 1916: Patient taken to operating room and hæmostats removed. Slight bleeding again occurred which was controlled by packing. Still has pain in the left chest. Has developed a few râles.

August 22, 1916: Bled a small amount last night which was controlled by pressure. Has developed a pulsating tumor under the line of incision.

August 23, 1916: Bled from the wound again last night, controlled by packing.

August 24, 1916: Pulse suddenly became worse and the patient died in a few minutes.

An autopsy was performed by the coroner's physician and it was found that the bullet had taken the following course: Entering the right side of the neck one and a half inches above the clavicle and one and a half inches to the right of the median line, it passed down and back, partially severing the carotid at its junction with the innominate, it then passed through the edge of the third dorsal vertebra, pierced the fourth rib, and lodged underneath the skin as previously described.

In the wound in the neck was a large traumatic aneurism. In the left thorax was a pint of fresh blood and it was the opinion of the one performing the autopsy that death was due to this hemorrhage and that it was caused by a rupture of the fourth intercostal artery. The rupture of this artery was due to a spicule of bone on the fourth rib.

The reporter added that Thompson (*So. Surg. and Gynec. Trans.*, 1914, vol. xxvii, p. 110), in an excellent article entitled "Ligation of the Innominate Artery for Cure of Subclavian Aneurism," reports a case of his own, reviews the literature on the subject and records in detail all cases operated on for ligation of the innominate since 1880.

Since Thompson's article, Carl A. Hamann (*Cleveland Med. Jour.*, 1916, xv, p. 221) has reported two cases as follows:

CASE I.—*Subclavian aneurism*.—Colored male, aged twenty-five years. Operation, ligation of innominate and common carotid. At time article appeared, which was two months after the operation, the patient was well.



## PHILADELPHIA ACADEMY OF SURGERY

CASE II.—Female, aged fifty-nine years. A fusiform aneurism of the innominate at its junction with the common carotid and subclavian. Operation, ligation of the innominate. The patient died the fourth day after operation of cerebral anæmia.

Nearly all the cases reported were operated for spontaneous aneurism and the remaining few for traumatic aneurism or injury to the artery.

Harte (ANN. SURG., 1897, vol. xxvi, p. 488) reports a case of injury to the common carotid due to a pistol wound. The innominate and common carotids were ligated in this case.

Leutas, Hernandez and Saigo report cases of injury to the carotid and subclavian, requiring ligation of the innominate.

Of the 52 cases collected by Thompson, forty-one were operated for spontaneous aneurism, 6 for traumatic aneurism, and 5 for wounds of large arterial trunks. Of this number, 16 recovered.

Secondary hemorrhage and cerebral anæmia were the most frequent causes of death.

A summary of the cases reported in the literature up to date and including the present case is as follows:

	Cases	Rec.	Died
Ligation of innominate alone .....	37	7	30
Ligation of innominate and carotid simultaneously.....	16	10	6
Ligation of innominate, carotid and vertebral simultaneously....	2	0	2
	—	—	—
	55	17	38

DR. JOHN SPEESE said that he had recently operated upon a patient with an unusual stab wound of the neck. The patient, a colored man, had been stabbed with a large butcher knife, the blade penetrating the tissues of the neck for a distance of about six inches. The man was almost exsanguinated from the constant flow of blood from the wound, the hemorrhage had been partially controlled by packing. The wound, enlarged under novocaine anæsthesia, was found to extend from about the middle of the left sternocleidomastoid muscle, some fibres of which were cut, to the sternoclavicular articulation. The jugular vein was seen but was uninjured. Toward the bottom of the wound there was a discharge of frothy blood, evidently due to an injury to the apex of the lung. The hemorrhage from the lung was easily controlled by packing, and the patient returned to the ward. On the following day he had

## STAB WOUND INTO RIGHT AURICLE OF HEART

a slight elevation of temperature, and on examining the chest the left side was found to be clear and resonant, whereas, the opposite pleura contained all the signs of an exudate extending to the angle of the scapula. The effusion was gradually absorbed, the patient making an uninterrupted recovery. The case is reported because of the small amount of damage inflicted by a knife of such size and because of the production of a pleural effusion on the right side when only the left apex of the lung and pleura seemed to be injured.

## STAB WOUND INTO THE RIGHT AURICLE OF THE HEART

DR. CHAS. F. NASSAU reported the history of a young man, nineteen years of age, who was admitted to St. Joseph's Hospital on September 26, 1913, while Dr. J. Chalmers DaCosta was on ward duty. The reporter happened to be operating at the moment of his admission, so that the care of the patient in emergency fell to him.

*History.*—During an altercation the patient had received a thrust in the left upper portion of the chest from a keen narrow-bladed fish knife some three inches in length. He was quickly brought into the hospital by the patrol wagon and transferred speedily to the operating room.

The wound of entrance was in the third interspace on the left side, about one inch from the edge of the sternum. The patient's pulse was extremely weak and the pulse rate so rapid that it could hardly be counted.

Under light ether anæsthesia an incision was first directed along the left border of the sternum for a distance of about three inches, including the third and fourth ribs. From this sternal incision, two others were made laterally from either extremity of the perpendicular incision. These lateral incisions over the intercostal space were about three inches in length. Trap-door of chest wall was then raised up to the outer side. In turning up the flap of the chest wall, the pleural cavity was opened. When the pericardium was exposed, it was seen to be filled with blood, which was oozing from a small wound. The pericardium was incised. Upon opening the pericardium, blood gushed out in great quantity, making it very difficult to determine exactly where the heart had been injured. Quick sponging showed the wound to be in the anterior surface of the right auricle, about five-eighths inch in length. A fine silk suture was inserted at the upper angle and tied, after which four continuous stitches were taken. No attention was paid to the phase of the heart cycle during suturing. After placing this suture, it was necessary to introduce two interrupted sutures of fine

black silk, to check some oozing along the suturing line. After cleansing the pericardial sac, an iodoform gauze drain covered with gutta-percha tissue was inserted at the junction of the vertical and lower horizontal incisions. A second drain was placed in the pleural cavity alongside of the drain into the pericardium. Through-and-through silkworm-gut sutures were used to close the wound. The patient stood the operation very well and at the close his pulse rate was of good volume and had dropped to slightly over ninety.

The wound healed by primary union, the pericardial drain being removed first at the end of about forty-eight hours. The pleural drain was removed in four days. Convalescence was smooth but in a few days patient began to run an irregular temperature with physical signs of pleural effusion on the left side. On October 6th, a piece of the sixth rib on the left side was resected, and about two quarts of septic pleural effusion evacuated. With the exception of the irregular temperature, which lasted for some time, he made a complete recovery and was discharged from the hospital on November 29, 1913, in a very satisfactory condition.

The reporter added that his experience in this case was that there cannot well be any chosen time in the heart cycle for the introduction of sutures, for the heart in this instance was merely a quivering mass of flesh without determinable systole or diastole. He now believed it was unnecessary to put a drain in the pleural cavity. He was certain that it was necessary to drain the pericardium, for it is much better to finish the operation quickly than to spend too much time in cleansing the pericardium, and there must be, of necessity, considerable blood behind the heart to be drained out. In this patient, the drainage was profuse for the first twenty-four hours, and upon removing the drain there was a considerable gush of blood-stained fluid.

Through the kindness of Dr. Willis F. Manges, he had an X-ray made last week, more than three years after injury, showing the entire thorax. Dr. Manges reports that there are no adhesions of the lung to the diaphragm, and that, except for a slight defect in the sixth rib, he would be unable to state that any operation had been performed upon this boy. There is nothing to show where the ribs were divided along the sternal margin.

#### STAB WOUND INTO THE LEFT VENTRICLE OF THE HEART

DR. J. F. JONES reported the history of a young man, aged eighteen years, who was admitted to St. Joseph's Hospital, April 18, 1916, at 3.00 P.M. He had plunged a large and not especially clean penknife into

## STAB WOUND INTO LEFT VENTRICLE OF HEART

his chest about fifteen minutes before reaching the hospital. The patient walked into the dispensary from the patrol wagon, a distance of about twenty-five feet, and placed himself upon the examining table with little or no assistance.

From the amount of blood on the patient's clothing, it was judged that the hemorrhage must have been quite profuse, but upon cutting away his shirt, no blood whatsoever was issuing from the stab wound. There was a small wound in the fourth interspace about one inch internal to the midclavicular line. Pulse was 148, of fairly good volume and regular at first, but later showing a tendency to intermit. The temperature was not taken. Patient was ordered to the operating room, and while being prepared became unconscious. Fifteen minutes had elapsed from the time of his admission to the time that he became unconscious, or one-half hour from the time of stabbing. Five minutes more elapsed before the commencement of the operation. When the incision was begun, thirty-five minutes after the infliction of the wound, the patient's pulse could not be felt and he was apparently not breathing.

A vertical incision was made to the left of the sternum, beginning at the second rib and extending downward for about five inches; the cartilages were cut through, and at each extremity of this vertical incision, a horizontal incision was made in an intercostal space extending about three inches in the direction of the midaxillary line. The flap thus formed was turned upward and outward by fracturing three ribs.

The pericardial sac was found distended and the heart was not beating. There was a very small puncture wound in the sac low down. When the pericardium was opened, a large amount of blood, both clotted and liquid, gushed forth and immediately thereafter the heart began to contract violently and with great rapidity. There was a small puncture in the heart near its left margin, close to its apex and extending into the ventricular cavity. The wound in the heart was slightly larger than the one in the pericardium. Three interrupted silk stitches were introduced into the ventricular wall and the pericardium was sutured with a continuous silk stitch, a small opening being left at the lower angle of the pericardial incision and the sac drained by a small piece of plain gauze. The pleural cavity, which had been opened, was also drained by gauze. Nearly a quart of salt solution was introduced intravenously during the operation.

The patient was on the operating table about three-quarters of an hour. At 8.30 A.M. of the morning following the operation, temperature was 98, pulse 110, and respiration 50. Respiration remained at 50 for three days, and gradually descended to normal. Gauze drain was

removed from pericardium on the fourth day and from pleura on the thirteenth day. There was a stitch infection at the upper and outer angle of the skin flap. The patient was discharged from the hospital on the seventy-seventh day after operation.

His present condition is best expressed by the reports of Dr. Willis F. Manges and Dr. Ross V. Patterson, both of whom have examined the patient quite recently, October 5, 1916.

Dr. Patterson reports that the patient "complains of occasional moderate degree of precordial pain, some dyspnoea on exertion, and at times a rapid heart. A careful examination failed to reveal any gross abnormal signs of cardiac damage, or disturbance in the mechanism of cardiac contraction. A walk of two miles at an ordinary gait was accomplished without undue fatigue. There was a moderate degree of cardiac impairment for unusual effort. The pulse at rest was 78, systolic pressure 115, diastolic pressure 85. There was no evidence of displacement, enlargement, or dilatation. The area of visible cardiac impulse was visible from the second to the fifth interspace within the midclavicular line. Systolic retraction at the apex in the fifth interspace in the anterior axillary line was probably due to pericardial adhesions."

The report of Dr. Manges is as follows: "Fluoroscopic observation reveals a normally pulsating heart except that the rhythm is somewhat disturbed. There is practically no deviation in the position of the heart. The diaphragm moves freely on both sides, and is free from adhesions. Stereoscopic plates show that the third, fourth and fifth ribs have been fractured, about one inch or more external to the ostochondral junction. They are united by bony union with considerable angulation. There is no evidence of disease of the lung tissue or of fibrous tissue formation. The heart seems to be a little above the average in size."

## CASES OF INFECTIOUS ARTHRITIS

DR. WILLIAM JACKSON MERRILL related the history of a patient who had every symptom of tuberculous arthritis of the hip—muscular spasm, rigidity, tenderness on motion and the systemic symptoms. There was a history of tonsillar infection, followed by arthritis of the left hip with the usual symptoms, and it was under desultory treatment for nearly a year, the hip-joint improving not a bit. The patient came to the University Hospital and was sent to the nose and throat department where the tonsils were removed, shortly after which the hip began to improve. A plaster bandage was worn for protection and in about

## CASES OF INFECTIOUS ARTHRITIS

eight months the hip-joint had almost normal motion. In a year motion had entirely returned and the tenderness had entirely disappeared.

Also the history of a child who had a recurrent arthritis in the opposite hip after removal of tonsils. There was periarticular thickening about the right hip with marked muscular spasm and tenderness on motion. Immediately following tonsillectomy the joint began to improve. About a year ago she began to have trouble in the other hip-joint. She was sent to the nose and throat department where no tonsillar trouble was reported. The adenoids, however, were removed and the hip-joint disease entirely disappeared—a coincidence since it was proven that there was no throat infection and that the adenoids had nothing to do with the recurrence.

The third case had a very acutely affected right knee. There was muscular spasm; practically no motion; much tenderness and swelling, but without very marked general systemic disturbance. Under rest and treatment the patient improved slightly. The tonsils were removed. After a stay in the hospital of two or three weeks the disease subsided and the patient went home with a plaster bandage from the crests of the ilia to the toes, which he wore for a short time. There is now absolutely normal motion in the knee-joint and no tenderness.

In two other cases, boys of the same family, he saw the first seven years ago when he had a very acutely affected hip with the usual local and systemic symptoms, and the family was told that the child had a tuberculous hip-joint disease. The hip-joint was absolutely rigid; the X-ray showed no organic changes, but there was a great deal of periarticular thickening, the tonsils were so enlarged that they almost touched each other. They were removed and in six months the hip-joint disease was much improved. Pain on motion had nearly subsided but there was still some restriction of motion. In about fourteen months he could walk normally.

The second boy had a polyarthritis, the left hip being practically stiff; he could move the right hip slightly. His knees were also quite rigid. One shoulder-joint and his wrists were affected. His throat was in the same condition as his brother's and the tonsils were likewise removed. Now, while there is some slight enlargement in the wrists, the joints are flexible. The boy was treated for a year and a half in the nose and throat department.

In yet another case the patient was admitted to the hospital July 28, 1916, with the knee in the condition shown with apparently a good deal of organic change. Under rest and treatment all symptoms disappeared and there is no evidence now of any joint irritability except a

slight roughness on one side of the epiphysis of the femur which he did not believe represents organic change.

Dr. Merrill added in reply to questions, that laboratory examination of the tonsils removed was not routinely carried out in these cases. All the work attending the removal of the tonsils was done in the nose and throat department, and so far as the bacteriological examination is concerned they had no report. The tonsils were, however, reported cryptic and containing pus. Some of the cases reported, and others of the 40 or 50 on record at the dispensary, seem to prove that the tonsils were an etiological factor. Some of the cases which presented recurrent arthritic attacks in the same or other points at intervals of from six to eighteen months recovered entirely after removal of the tonsils. The first and fourth cases had such a history. Some of the cases were not admitted to the hospital for treatment but had their tonsils removed and measures for the improvement of the general health were carried on at home, treatment of the throat being administered in the nose and throat dispensary; it would seem, therefore, that these cases, having recovered after the local infection, were not tuberculous but due to the septic infection of the tonsils.

So far as the test for tuberculosis is concerned he did not know how a positive conclusion could be reached. Von Pirquet himself said that his test is worthless after the age of four and all surgeons know the value of the subcutaneous and intracutaneous tests. Tuberculous joint disease has a pretty definite course and history, and persists even after the removal of tonsils, adenoids, teeth and, in fact, the correction of any other trouble. It presents a picture which is recognized by experience and which is unmistakable. The general and local symptoms during the onset are entirely different in tuberculosis when compared with the septic. The manifestations in and about the joint, even in the very beginning, in the case of tuberculosis show trophic changes which do not appear in the septic. A mild case of tuberculosis might be mistaken for septic arthritis. In many of his cases the hygienic conditions had been good. He did not feel, therefore, that the hygienic surroundings in these cases were important. It is said, that certain cases recover without having the tonsils removed. Similarly many cases of tonsillitis get well, the disease coming on quietly and after a time, subsiding, with no concomitant joint disturbances. At other times joint affections occur with attacks of tonsillitis and get well after the subsidence of the tonsillar disease. Again joint diseases follow tonsillar infection, become subacute or chronic and persist for an indefinite time.

Regarding the relationship of the involvement of the joint and the

epiphysis in the cases studied, he had rarely seen epiphysial involvement.

DR. GWILYM G. DAVIS said that in comparatively slight cases it is impossible to prove absolutely the existence of an infectious cause. In recent years the dependence of arthritic troubles upon infection has in a few cases been demonstrated as a certainty, and in a larger number of cases with a certain degree of probability. Many cases, however, are not sufficiently marked to enable us to localize the origin of infection. The doctrine of infection as a cause of chronic joint disease has, however, gained ground. Particularly in the older case reported the question of a metabolic cause may arise as in the hypertrophic arthritis of adults. In young cases such as those shown by Dr. Merrill, the metabolic cause would not be so probable. In those, of course, one would consider the possibility of traumatism without infection, and specific infections such as syphilitic and tubercular. Joint troubles are gradually being systematized and when not simply traumatic are usually found to be tuberculous, or infectious, and disturbed metabolism as a cause seems to be losing ground.

DR. A. BRUCE GILL said that the diagnosis of the cause of arthritic conditions in children often presents a difficult problem. The Von Pirquet test done routinely usually will be found positive except in very young children. Often by putting these children at rest in bed with extension their symptoms quiet down and they are discharged from the hospital wearing a case and walking on crutches. As time passes they acquire good motion, and upon examination the joint is apparently normal. All have seen many arthritic cases clear up without treatment except putting the patient at rest and without excision of the tonsils. Orthopædic clinics are flooded with arthritic cases of all kinds and in these days the theory of focal infection is greatly emphasized. Every effort is made to discover and to remove the source of such infection. Notwithstanding the fact, however, that patients are referred to the nose and throat and gynæcological departments and to the dentist and elsewhere for removal of such focal infection, in many cases the arthritis remains unchanged.

DR. P. G. SKILLERN, JR., thought Dr. Merrill's series of joint infections to be instructive because of the clear relationship he has established between effect and cause, as was demonstrated by the prompt improvement and ultimate cure after the tonsils were ablated *in toto*. He said ablated *in toto* in order to "knock" those operators who are satisfied with performing partial tonsillectomy by means of the tonsillotome. This is a procedure that is about as logical as removal of a portion of the appendix for appendicitis. There is no reason to suppose



that the outer, or buried, portion of the tonsil is any less diseased than the inner, or exposed, portion—a conclusion that the operation of partial tonsillectomy presupposes. As a matter of fact both bacteriologic and pathologic-histologic examination of totally ablated tonsils show that the outer, or buried, portion of the tonsils is also involved in the disease of the inner portion, which is more evident to the naked eye at the time of physical examination, and that this outer portion exhibits no such immunity to disease as the partial tonsillotomists would have us believe. Nay, more: recent investigations have shown the *capsule* of the tonsil—the outermost portion—is frequently diseased, particularly in tuberculosis, so that any operation must be discarded which does not remove the capsule together with the tonsil.

Dr. Merrill described a case of metastatic arthritis of the hip-joint in which recrudescence followed “removal of the tonsils.” This recrudescence suggests the probability of the tonsils not having been wholly removed—an inference that seems more logical than the essayist’s adenoid hypothesis, for he did not see how adenoids with their smooth and oedematous mucosa could act as portals of entry for bacteria, unless the adenoids were the seat of ulcerous processes the result of trauma.

The pathology of Dr. Merrill’s cases was probably not sufficiently extensive, judging by the short clinical course, to warrant the use of so comprehensive a term as “arthritis.” The term “serious synovitis” would doubtless apply, the bacterial emboli lodging in the subsynovial vascular layer and by their toxins irritating the sensitive synovial layer itself until a serious effusion—at first bacteria-free—is poured into the joint cavity from the congested membrane.

Given a case of joint disease, it often requires a painstaking and exhaustive study to detect and establish the primary focus of infection. The work of Rosenau in the bacterial, and of Pemberton, of Philadelphia, in the non-bacterial or metabolic joint-disease, has already shed much light upon the pathogenesis and successful treatment of these respective lesions.

#### ACIDOSIS IN SURGICAL CONDITIONS

DR. J. HAROLD AUSTIN said that normally  $\text{CO}_2$  is present in the tissues at a tension of about 80 mm.; in the alveoli of the lungs and in the arterial blood leaving the lungs, at a tension of about 45 mm. Every unit of arterial blood as it passes through the tissues takes up a certain load of  $\text{CO}_2$  as a result of this difference in tension, and reaching the lungs loses this  $\text{CO}_2$  there. When there is a diminution in the “buffer substances” of the blood there is a diminution in the amount of  $\text{CO}_2$

## ACIDOSIS IN SURGICAL CONDITIONS

which each unit of blood can take up in response to a given increase of  $\text{CO}_2$  tension. In consequence there follows a diminished removal of  $\text{CO}_2$  from the tissues and among others from the respiratory center. The accumulation of  $\text{CO}_2$  results in a higher  $\text{CO}_2$  tension in the center and this in a stimulation of the center with increased alveolar ventilation so that the center may have a  $\text{CO}_2$  tension of what we will suppose 85 mm. and the alveoli of the lungs of 30 mm. The difference of  $\text{CO}_2$  tension between the pulmonary alveoli and the tissues will thus have been increased from 35 mm. to 55 mm. Now it is possible that in spite of the diminished "buffer substances" in the blood the amount of  $\text{CO}_2$  taken up by each unit of blood under the influence of this increased difference of  $\text{CO}_2$  tension will be sufficient to maintain an adequate transfer of  $\text{CO}_2$  from the tissues to the lungs and establish an equilibrium upon this new basis.

To recapitulate: The  $\text{CO}_2$  carrying capacity of the blood is diminished for a given difference in  $\text{CO}_2$  tension. This interferes with the removal of  $\text{CO}_2$  from the tissues, including the respiratory center. This stimulates the respiratory center, leads to hyperpnœa and an increased pulmonary ventilation. *This increases the difference of  $\text{CO}_2$  tension between tissues and pulmonary alveoli, and this in turn increases the amount of  $\text{CO}_2$  carried by each unit of blood and re-establishes an equilibrium.*

The only clinical feature characteristic of these cases is the peculiar deep respiration without cyanosis with the usual association of headache and frequency of vomiting. It is the very inability to recognize acidosis on the symptom-complex alone which makes the tests for acidosis of value, and it is our knowledge of these tests which will enable us to detect unsuspected cases of acidosis.

DR. ASTLEY P. C. ASHURST said that the laboratory men and the physicians in the last few years have brought the surgeons to the realization of the fact that starvation, among other things, is a potent cause of acidosis. When we see children in the wards who are homesick and do not eat, we do not operate on such children until they become accustomed to their surroundings, when they begin to eat and get better. Surgeons did not formerly recognize that anæsthetization and operation on such patients before this improvement occurred, might result in the death of the child from acidosis. He recalled one such case in which death occurred a number of years ago, following a double osteotomy for knock-knees. We then thought it a case of status lymphaticus: the child's temperature rose rapidly after operation, respiration was exceedingly rapid, and she died within a few hours. Autopsy showed nothing

very conclusive. No doubt death was due to acidosis. This patient starved herself before operation because of her unhappiness and homesickness. There can be no doubt that in many cases in the past, where we have thought death was the result of the operation, it was really due to acidosis; and that the fatal termination might have been averted if operation had been postponed. Acidosis, as pointed out by Crile, is greatly to be feared in cases of advanced peritonitis; and in such cases it is often acidosis and not bacterial intoxication that is responsible for the patient's death.

#### EXPERIMENTAL CHEMOTHERAPY OF BACTERIAL INFECTIONS

DR. JOHN A. KOLMER, by invitation, read a paper with the above title.

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## THE CHOICE OF OPERATIVE PROCEDURE IN CANCER OF THE RECTUM AND PELVIC COLON\*

BY CHARLES H. MAYO, M.D.

OF ROCHESTER, MINNESOTA

ONE of the most serious, as well as one of the most interesting, surgical problems is the choice of methods in dealing with cancer of the rectum. It is serious because when unrelieved the disease leads surely to slow death, usually accompanied by much suffering. It is interesting because so many considerations are involved which influence the decision as to whether any operation is indicated either palliative or radical, and if so, what. The first of these considerations is the location of the area involved by the cancer and the forms of the metastases; the second is the extent of the local disease and the associated local or general disease. Obesity increases the risk. The decision as to a palliative or radical operation will be influenced also by freedom from contact dissemination or grafts at a distance within the abdomen.

The intelligent patient usually inquires whether there is any other way of treating the disease than by surgery. If not, he wishes to know the operative risk and the prospects of cure; whether he will retain control of his bowels, and whether the new opening will be behind or in front? Among other methods of treatment, the use of radium is making great strides in the treatment of cancer, but at the present time it is limited to particular cases of local involvement, or to inoperable conditions. Radium treatment can hardly be classified in elective cases as being in any way in competition with the surgical treatment of cancer of the rectum except for epithelioma of the anus.

*Operability.*—Operability is a most important question. If the operability is high in a given clinic the mortality will be high. The reverse is true of a low operability, for if only the best cases are selected

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\* Presented before the Southern Surgical and Gynecological Association, December 11, 1916.

for operation, the risk will be less. In order that the student may judge operative results all statistical reports must include a statement regarding the operability. Cripps performed radical operations for cancer of the rectum on only 107 of 425 cases, an operability of less than 25 per cent. In the five years preceding 1916 our total operability was 53 per cent., but in the last three years it rose to 71.8 per cent., indicating that a chance for cure is now being given to a larger percentage of patients with this otherwise hopeless condition than formerly. That the operation is becoming more extensive is shown by the fact that in 6 cases we have performed, in addition, a total hysterectomy; in 12 cases we removed the posterior wall of the vagina; in 6 cases the posterior wall of the bladder; in 11 cases a part or all of the prostate, with one or both seminal vesicles, and in 6 cases one or more coils of small intestine. All of these procedures were necessitated by contact extension of the disease.

*Mortality.*—Of 753 patients in the Clinic a radical operation was performed on 430, with a general operative mortality of 15.5 per cent. Before 1910 the operative mortality was 17.8 per cent. From 1910 to 1913 it was 17.7 per cent., the operability being 51 per cent. In this earlier period a higher percentage of cases was seen late. Even at the present time 14 per cent. of the patients with cancer of the rectum observed have not had a complete physical examination, although they have been under treatment elsewhere, and some even have been recently operated on for hemorrhoids. In 1913, 1914 and 1915 the mortality was reduced to 12.5 per cent., the operability was raised to 71.8 per cent. and the operative efforts were more radical.

Judging from the character of the colonic contents it would seem that the lymphatic system of the large bowel is very inactive, very much less active than that of the small intestine. For this reason cancer remains a local disease for comparatively long periods of time. That metastasis through the lymphatics is somewhat modified also by age is evident from the fact that in old people cancer remains a local disease longer than in young people. In a considerable number of necropsies performed on persons who have died from cancer of the rectum without operation it is found that there was little or no glandular involvement, death having been caused by perforation, peritonitis or obstruction. The question as to operability and probable operative risk can often be answered by a general examination. In many cases, however, it is necessary to make an abdominal exploration to determine the advisability of a radical operation.

*Prognosis.*—Of the number of patients operated on, none less than

## CANCER OF THE RECTUM

three years ago; one-third lived three years or more and 28.3 lived five years or more. By subtracting the natural death-rate for the age period and the number of years, these percentages become respectively 37.5 and 35.8. Greater knowledge of the disease by the public will improve the present statistics for both the mortality and the cure.

The question of control of the bowels must be considered from several standpoints. Colostomies and uncontrolled intestinal openings for the escape of feces, whether they are abdominal or perineal, are much alike if the sigmoid loop is destroyed in making the new opening. As the left side of the colon is largely muscular and there is no impediment to the discharge of bowel contents after they have passed the splenic flexure, the patient with no anal control and with the sigmoid loop eliminated is much better off with an abdominal than with a perineal anus. If with loss of the anus the sigmoid loop can be retained, the control will be fair, except in case of loose bowel movements. Gas, however, is not controlled. If the cancer is low and the patient is obese, or there are other special reasons, a perineal operation may be chosen without abdominal exploration. With modern technic, however, various forms of abdominal colostomy are possible by which a very fair degree of control can be maintained and abdominal exploration permitted. Undoubtedly a considerable percentage of the Kraske operations done without abdominal exploration were on patients who had no possibility of cure because of internal metastases. Also much of the failure as to permanency of cure by the operations of earlier days was due to lack of exploration and to extraordinary efforts to preserve the normal or posterior location of the anus. Before 1900 the mortality was approximately 20 per cent. with over 90 per cent. of recurrence. We believe that much of the progress in the surgery of cancer of the rectum has come from abdominal exploration and the abdominal colostomy with the sacrifice of a large area *en bloc* of the diseased bowel. The main purpose of the operation being to cure, the best results are secured when unhampered by any special effort to re-establish the normal control of the anal outlet, except when it is indicated by reason of the location of the cancer. While the union of resected intestine within the abdomen is not followed by stricture, that effected outside of the peritoneal-lined abdomen is practically always followed by stricture, and will usually necessitate some form of colostomy after much effort to maintain the lumen. This is the more true if there is good control of the anal sphincter and the less true if the sphincter is paralyzed. As to the extent of bowel to be removed Fagge shows that the disease may extend two inches lower than the apparent growth, while according

to Handley it can be found microscopically more than double that distance above the manifest disease. Such, however, are advanced cases and each individual case must be dealt with on its own merits. In the surgical treatment of malignancy, modern progress has been made by earlier diagnosis and increasingly radical operations. Local recurrence calls for exploration.

The term "rectal cancer" is applied to such growths as are found anywhere between the anus and the lower sigmoid. On anatomic grounds the first inch and a quarter is the anal canal that is lined with pavement epithelium. About 6 per cent. of cancers of the rectum are found in this area. Here appear the epitheliomas and extensions of adenocarcinoma from the lower rectum. Very early local epithelioma may be successfully treated by local excision or destruction by cautery. More extensive disease necessitates the Cripps operation of excision of the anus, which should also include the removal of the inguinal glands, this region having a double lymphatic return. From the anal canal to the peritoneal-covered intestine is the lower rectum, in which are found 24 per cent. of the malignant growths of the region, usually adenocarcinomas, the common form of rectal cancer. The Cripps, Quenu-Tuttle and Hartmann operations, with or without the removal of the coccyx, have been the common operative procedures, the upper rectum at times being drawn through the mucus-denuded anal canal, to be sutured outside for maintenance of the normal position of outlet, or more commonly brought to the surface at the former position of the coccyx. The upper rectum extends to the rectosigmoid juncture opposite the third sacral vertebra. The Kraske procedure involves more extensive removal of the lower sacrum with the coccyx, a higher placement of the terminal bowel and a more extensive removal of the rectum. Operation for cancer of the rectum and rectosigmoid should be made by the two-stage interval operation. If by abdominal procedure the division of bowel below the growth can be made at a point which will leave at least one-half inch or more of peritoneal-covered rectum within the cul-de-sac, and the area of the disease to be removed is not too great to prevent coaptation of the divided ends of the bowel, a tube resection can be done with preservation of the control of the anal outlet as a one-stage procedure. A large rubber tube with a one-half-inch lumen is inserted into the terminal proximal opening of the intestine and attached to it by a purse-string suture. The tube is now passed into the rectum from above and out of the anus. As the bowel ends approximate they are sutured and the tube, being further drawn upon, enfolds the suture line into the rectum. A second row of sutures is then applied, and

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upon further traction a third row of sutures. All intestinal contents are passed through the tube and in no way come in contact with the suture line. The anal sphincter is temporarily relaxed by dividing it anteriorly with the cautery. The tube is sutured with catgut to the anus and its position maintained for one week. Cancer of the rectum and rectosigmoid, which cannot be radically removed with the preservation of the peritoneal-covered distal bowel, is best treated by abdominal exploration, permanent abdominal colostomy and a Kraske removal of all of the rectum at a period one week later—a two-stage operation. Cancer of the lower sigmoid extending nearly to the rectosigmoid is well treated by the Mikulicz method, separation of the mesentery and elevation of the diseased loop through the exploratory incision to a position above the abdomen. The sides of the intestine being first attached to each other within the abdomen to prevent the engagement of small intestine, the doubled intestine is sutured to the parietal peritoneum at the point of emergence and the tumor packed roundabout with vaseline gauze. At the end of a few days the diseased area is excised with the cautery, both ends of bowel being left open, the upper acting as a temporary colostomy. From the second to the fourth day it is sometimes necessary, before amputation of the tumor, to puncture the proximal side of the loop with a cautery, to deliver the gases. In some instances the amputation of the growth may be primary, the ends of the bowel being held by crushing clamps for a few days. From eight to ten days following the primary operation long-bladed crushing forceps are applied by passing one blade into each of the intestinal tubes, the tissues being crushed by tightening the forceps each day. Usually on the fifth day they cut through, making an entero-enterostomy from within the intestine. In from one to several weeks later, according to the case, the external fistula may be closed. This three-stage operation is one of the safest for the amount of diseased tissue removed. It overcomes the dangers of leakage from resection. In selected cases Bloodgood has obtained the same result in a primary operation by resecting the growth, closing both ends and connecting the sides of the sigmoid loop with a lateral suture anastomosis, the closed ends of the bowel being brought into the abdominal incision to be opened if necessary. We have accomplished the same thing by excising the tumor, uniting the proximal end of bowel to the sigmoid end-to-side and bringing the distal end of the sigmoid into the abdominal incision but not through the muscle. The end which is invaginated by a purse-string is not opened unless necessary for gas tension. A rectal tube is inserted for additional safety. The combined perineal and abdominal one-stage operation is a very



radical procedure and is responsible for a high mortality, 20 to 36 per cent. This has been lowered somewhat by Cripps by making the abdominal pelvic dissection, closing the abdomen and, by posterior operation, immediately elevating the rectum and sigmoid, the bowel not being cut off for two or three days. With exceeding safety we have operated by abdominal incision dividing the sigmoid, making a permanent abdominal anus, and after closing the distal sigmoid of bowel with its invaginated end into the pelvic space, closing the brim of the pelvis with peritoneal-covered tissues and peritoneal folds, such as the back of the bladder or the uterus. The total removal of the rectum and lower sigmoid is done at the end of one week through a perineal Kraske incision. By this method the general cavity of the abdomen is not opened at the second operation.

## THE INFLUENCE OF ACIDOSIS ON SURGICAL PROCEDURES\*

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THE treatment of most surgical diseases has now reached a fairly uniform and stable condition so that the advances of the future must come from a broader knowledge of physiology and pathology. We must thoroughly know and understand all the various processes that go to make up the complex phenomenon of human life in health, as well as the changes brought about in these processes by various abnormal or diseased conditions. It is of the utmost importance that we recognize and estimate the various factors of safety that nature has provided. Any surgeon with a fairly extensive experience can soon develop a technic and knowledge of the best procedure for certain diseased conditions which he finds as time goes on he is not able to improve very markedly. But by a broader study of the patient and his vital processes he is able to recognize and avoid many pitfalls, especially those not intimately connected with the condition under treatment. Thus may we achieve that for which we so earnestly strive—the lowest possible mortality. The consideration of the condition known as acidosis thus becomes of interest to every surgeon because, as we shall see, the question of the proper reaction of the media in which the body cells function is a most vital one to all forms of life. Crile,<sup>1</sup> in an extensive study of the subject, has pointed out that an alkaline medium is necessary for all life. When the soil becomes acid it must be fertilized by adding alkali. Thus also in the living organism an alkaline medium is necessary to the continuation of life, and as would be expected, a somewhat complex process has been built up to see that the necessary alkalinity is always maintained. There are two factors to be considered in this process: (1) Production of acids; (2) their destruction or elimination.

Excessive loss of bases, as in cases of severe diarrhoea, may have an influence, but no conclusive work has been done to demonstrate that in these conditions more base than acid is lost.

(1) *Acid Production*.—Crile<sup>1</sup> has shown that almost every activity of life produces acid. Every movement, every emotion, every injury,

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every degree of fever, every reaction to infection or auto-intoxication, every heart-beat or respiratory movement, and more especially such an abnormal condition as the administration of an anæsthetic, and such diseased conditions as Graves' disease, post-operative hyperthyroidism, strychnine poisoning, etc., where there is an intense liberation of energy, but most important of all are those conditions where the body is unable to obtain or assimilate sufficient carbohydrates for its needs.

(2) *The elimination of acids* is brought about in both gaseous and solid forms. In the gaseous form as  $\text{CO}_2$  from the lungs, the consideration of which we do not need to discuss. The final portals of exit from the body for the acid products which are in solution in the different body fluids are the kidney tubules and the sweat glands. These by-products are at first not suitable for elimination, but must be changed by taking sodium, potassium, and ammonia from the body and changing them into harmless salts such as phosphates, sulphates, chlorides, urea, creatin and creatinin. In these forms they can be eliminated without injury to the kidneys. Crile has shown that the transformation takes place through the agency of the brain, the liver, and the adrenals. This mechanism is ordinarily quite capable of taking care of the acids formed in health with a large margin of safety. There are two ways in which it may, however, break down.

1. By an incomplete acid destruction or elimination.
2. By a too extensive acid production.

1. Under normal conditions the kidney excretes a very considerable amount of acid chiefly in the form of acid phosphates. Howland and Marriott<sup>2</sup> have shown that in severe cases of diarrhœa there is an increased phosphatic content in the blood and they consider the retention of the acid phosphate the most probable cause of acidosis occurring in cases of severe diarrhœa.

2. While in some cases the excretory mechanism may be at fault, the main cause of the condition and, for all practical purposes, the only one we need consider is an increased production, and this to a somewhat marked extent, because, as we shall soon see, the body is capable of neutralizing acid production far exceeding the normal. It may be well here to state that what really occurs is a decreased alkalinity of the blood and it is never carried to the point of actual acidity, death occurring long before this point could be reached.

Let us now examine those diseased conditions in which an increased production of acid is found. We might enumerate them as:

(a) Diabetes; (b) starvation (ulcers, fevers, acute abdominal con-

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ditions, prolonged vomiting, diarrhoea); (c) periodic cyclic vomiting; (d) delayed chloroform poisoning; (e) pernicious vomiting of pregnancy; (f) salicylate poisoning.

If you examine these conditions carefully you find one common underlying condition in all, viz.: the inability to obtain or assimilate carbohydrates. Allow me to briefly review how the lack of carbohydrates produces increased acid by-products. When carbohydrates fail the organism calls upon its reserve store of fats and proteids, but more especially the fats. Now a certain amount of carbohydrate is necessary to the complete oxidation of fats which are ordinarily oxidized to  $\text{CO}_2$  and would thus be eliminated from the lungs without difficulty. But in the absence of carbohydrates the process falls short, probably due to the fact that the carbohydrate molecule contains a large amount of oxygen which is used to help oxidize the fat, and thus some of the fatty acids make their appearance in the blood, such as acetone, diacetic acid and oxy-butyric acid. The body at first defends itself by calling up reserves of sodium and potassium and as soon as these fail it further defends itself by the production of large quantities of ammonia. This is obtained from the metabolism of proteid. Ordinarily the effete nitrogen of the proteid molecule is split off in the form of ammonia salts and this is converted into urea and thus excreted. But in the presence of these acids the ammonia is used to neutralize them and thus escapes conversion into urea. Estimation of the ammonia nitrogen and the urea nitrogen in the urine gives an early indication of the acid formation in the blood. Normally the ratio of the former to the latter is about 5 per cent., and if it rises to 10, 15, or 20 per cent., there is a severe acidosis which is masked by the ammonia neutralization and only when this begins to fail will the acids appear in the urine. Delayed chloroform poisoning is probably only a severe and prolonged form of acidosis produced in a patient with a tendency to acidosis by a long operation with chloroform anæsthesia and the consequent withholding of carbohydrates. In the acute cases there may be very few or no post-mortem changes, but in the chronic cases the changes are those found in acute yellow atrophy with fatty degeneration of the liver, kidneys, etc. Multiple small hemorrhages are also often found in the stomach.

*Occurrence.*—A varying amount of acidosis occurs in many familiar conditions, such as violent exertion, strong emotions, exhaustion from injury, infection, shock, starvation, hemorrhage, etc. The prominent clinical phenomena in a case of exophthalmic goitre and in post-operative hyperthyroidism are chiefly due to acute acidosis. Women are more

susceptible than men, perhaps due to their greater emotional tendencies. Children are much more susceptible than adults and here it is entirely due to their inability to bear carbohydrate starvation for any length of time. Deprive a child of carbohydrates for thirty-six to forty-eight hours and in most instances diacetic acid will appear in the urine, while the same deprivation in an adult would require a much longer time to produce any effect. The craving of a child for sweets probably has a physiological significance and must be kept in mind when a child is subjected to any prolonged strain, anæsthetic or operation. Brandner and Reimann,<sup>3</sup> studying 214 consecutive patients in John B. Deaver's service, found acetone present in 85 per cent. and diacetic acid in 17 per cent. of the cases. The more emotional, frightened or anxious they were invariably the more shocked and the greater amount of acetone was found. Starvation treatment was found to nearly always increase the acetone output. The severity of the pathological condition and the gravity of the operation did not seem to have any bearing on the condition.

*Symptoms.*—These vary depending upon the severity of the condition, all the way from a slight prolonged post-anæsthetic vomiting to the ones terminating in coma and death. In the mild cases all that is noted is that the patient goes under the anæsthetic with surprising ease and that the breathing is shallow and requires careful watching. There may also be a tinge of cyanosis when the patient is getting plenty of air. Later the patient is restless, vomits easily and the effects of the anæsthetic take a long time to wear off. In the more severe cases the patient may never regain consciousness, or if so, he becomes restless and tosses about. Vomiting is frequent and may be coffee ground in character. Thirst is marked and more or less cyanosis present. The pulse-rate rises and the respirations become hurried. The temperature often rises and may lead to a mistaken diagnosis of sepsis. The patient soon becomes comatose and in an adult may be delirious, death supervening in from twenty-four to thirty-six hours.

*Treatment.*—This becomes much simplified if we keep in mind that for all practical purposes acidosis means carbohydrate starvation. The acidosis produced by exertion, emotion, infection, anæsthesia, etc., in an adult can usually be handled by the organism without difficulty, provided there be not superadded that produced by a too severe withholding of carbohydrates. Thus the treatment in most cases reduces itself to the prevention of further trouble by supplying sufficient carbohydrate and to the neutralization of those acid by-products present by the administration of alkali. Certain classes of cases must

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be recognized as predisposed to the development of acidosis and thus receive special attention. These are children, patients suffering from forms of exhaustion, such as from starvation due to various pathological conditions, hemorrhage, chronic infections, extreme nervousness, hyperthyroidism, diabetes, etc. The urine must be carefully examined for diacetic acid, or better still, the ammonia and urea nitrogen estimated. These cases must not receive severe purgation and carbohydrates must be allowed right up to the time of operation, best in the form of glucose, either by mouth or rectum. Sodium bicarbonate may be administered until the urine is faintly alkaline. Wakefulness and nervousness should be controlled if possible and all forms of exertion prohibited. The operation should be performed as rapidly as consistent with proper technic and under local anæsthesia if any degree of acidosis be present. Crile<sup>4</sup> has shown that the anæsthetic distinctly increases the acidosis. He advises against the use of morphia after the anæsthetic as it prolongs the period of neutralization, but when given before the anæsthetic it lessens the amount necessary for anæsthesia and thus has a tendency to lessen the acidosis. Shock should be guarded against by the subcutaneous or intravenous injection of saline solution. There are two lines of treatment for acidosis following operations. The administration of alkali in the form of sodium bicarbonate which controls the symptoms by neutralizing the acids, and the administration of carbohydrates best in the form of glucose which overcomes the production of the excessive acid by-products, when they are due, as in most instances they are, to carbohydrate starvation. These may be administered by the mouth, by the rectum or intravenously. In the mild cases, the best method is to put them in the saline solution and use by the Murphy drip method. Glucose can be so used in percentages of 5 to 10, but is somewhat irritating and cannot be used for any length of time. Sodium bicarbonate may be given in the proportion of one to two drachms to the quart and may also be administered by the mouth until the urine is faintly alkaline. In the severe cases of coma present or threatened, a quart of 5 per cent. glucose and two or three drachms of sodium bicarbonate should be administered intravenously. The solution must be pure, fresh and well sterilized. We have in glucose a food substance which can be introduced directly into the circulation and readily utilized by the organism. Experiments by Vezar and Von Fejar<sup>5</sup> have shown that there is a definite increased oxidation after its introduction. A good practical method in children is to let them have loaf sugar or pure candy up to a short time before operation and as soon after as they will take it.

I can best illustrate the importance of this subject by recounting the histories of two cases: The first I saw in consultation during the early days of my practice before the question of acidosis had been brought to the notice of surgeons. The patient was a well-nourished boy of five years, suffering from a simple inguinal hernia. The parents were intelligent and well-to-do and, desirous of taking every precaution, thoroughly starved the child for several days before operation. The operation was easily performed under ether anæsthesia and the patient came through it nicely. Following the operation he had a tendency to vomit and again through excessive zeal food was rigidly withheld. With our present knowledge it is easy to foresee the result. On the second day the patient was still vomiting a little, was restless and the pulse and respirations more rapid than normal. The temperature rose to  $103^{\circ}$ ; the pulse became very rapid and weak. The patient became cyanosed and gradually comatose. The urine was not examined for diacetic acid but a slight trace of albumen was found, as is the case in most post-operative cases, and the condition was thought to be due to uræmia and treatment for this was instituted, which of course only hastened the ultimate end. Thus we have enacted one of the tragedies of surgery: A strong, healthy child—a simple operation—a fatal result. Had the condition been recognized it would have been a simple matter to overcome it, as the next case will demonstrate.

I saw this case only a few months ago. It was a little girl of nine years, brought in from the country suffering from acute appendicitis. The diagnosis had been made three days before by the family physician. The parents had some knowledge of the condition and had rigidly starved the patient for the three days. The appendix was found acutely inflamed and removed under ether anæsthesia without difficulty, in about twenty minutes. Following the operation the nurses were instructed to begin nourishment early, but the patient was indifferent and was not urged. On the second day the mother was sitting by the bedside and noticed a strange expression on the child and on speaking to her obtained no reply. She then found that she could not rouse her. When I saw her she was deeply unconscious; the pulse was 140 and thready; respirations rapid and jerky, with a tendency to Cheyne-Stokes. Face and hands were cyanosed and the face and eyes turned strongly to the left with some twitching of the eyes and limbs, especially on the left side. The teeth were tightly clenched and she was unable to swallow. I suspected acidosis, but no urine could be obtained. However, feeling fairly sure of my diagnosis, I gave her intravenously two pints of saline solution containing 5 per cent. glucose and two drachms of

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sodium bicarbonate. A change in the pulse and color could be noted at once and inside of two hours she was perfectly conscious, asking what had happened. Thus was a tragedy avoided. Carbohydrates were pushed and she made a perfect recovery. The urine first obtained after this contained diacetic acid, which soon disappeared.

The conclusions I wish to emphasize are the possibility of acidosis occurring in many conditions besides diabetes, and the necessity for surgeons to have their eyes open to its dangers. The necessity of a proper and continued examination of the urine for acid by-products and the danger in the preparation of patients for operations of a too prolonged starvation, especially in the case of children or those suffering from any form of exhaustion.

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# THE CHEMOTHERAPY OF EXPERIMENTAL BACTERIAL INFECTIONS\*

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FOR ages one of the chief aims of those concerned in the treatment of the sick has been the discovery of specifics. Consciously and unconsciously physicians have ever experimented with this purpose in mind and largely by empirical ways and means; despite the enormous amount of work entailed and the very large numbers of both organic and inorganic substances employed, only two or possibly three specifics have been discovered up to very recent years, namely, mercury for the spirochæte of syphilis, quinine for the plasmodium of malaria and salicylates for the infectious agent of acute rheumatic fever. In comparison with this rather poor record of definite achievement covering hundreds of years of effort is the brilliant discovery by Ehrlich of the specific spirochæticide arsenobenzol, after comparatively few years of work, and a striking demonstration of the value of the "prepared" mind and organized and systematic reasoning and experiment.

In a strict sense the term chemotherapy may be made to include the therapy of disease with any organic or inorganic chemical; indeed Wright has recently advocated the use of the term to include those immunity principles in the blood and other body fluids known as antibodies and regarded as being chemical substances. The meaning given the term by Ehrlich, however, would appear restricted to those chemicals built up synthetically and systematically with the object of rendering them more and more parasitidal for a certain microparasite or group of microparasites and less and less organotropic or toxic for the body cells. Future researches in the field of chemotherapy along systematic and scientific lines may discover chemicals already well known and requiring no further modification, but it is more likely that efforts in this field must be spent on the tearing down or building up of chemicals regarded on the basis of experiment or clinical experience as being

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## EXPERIMENTAL BACTERIAL INFECTIONS

hopeful "leads" or "bases" until the desired properties of extreme parasitotropism and low organotropism are acquired.

With discoveries in the field of bacteriology in the early eighties and of chemical substances readily demonstrated as possessing bactericidal properties in high degree in test-tube experiments, high hopes were entertained and expressed that the treatment of bacterial infections would soon be solved and greatly simplified. It was not long, however, before laboratory and clinical experiments demonstrated that chemicals possessing a high degree of bactericidal power outside of the body may be so highly toxic and their bactericidal properties so altered in the living body, as to prove well nigh worthless in the treatment of bacterial infections. The mercurials are notable examples of this class of compounds; at present in the Dermatological Research Laboratories of the Philadelphia Polyclinic we are endeavoring to prepare new synthetic mercurials with decreased toxicity and enhanced parasitocidal properties, believing that this group of substances possess great possibilities as efficient bactericidal and protozoöcidal substances in the living animal.

At present more advance in chemotherapy has been made in the field of protozoön than in bacterial infections. Such protozoa as the trypanosomes and certain races of spirochætes are readily adapted for extensive experiments in laboratory animals, proving comparatively simple in their handling and yielding results in chemotherapeutic experiments which are definite and decisive in a short space of time; for these reasons they have been adopted in most laboratories for researches in chemotherapy. Furthermore, it would appear that the problem of chemotherapy of protozoön infections is simpler than that of bacterial infections in that the protozoa, as trypanosomes and spirochætes, are more susceptible or open to the influence of chemicals in the body fluids, and that other modifying factors, as localization of the infection, accessibility to the influence of a drug and tissue changes, are less than occur in bacterial infections. The intensive work in syphilis during the last twelve years, including the discovery, isolation and artificial cultivation of *Treponema pallidum* and the Wassermann reaction, has served to focus the attention of scientific medicine upon this disease and protozoön infections in general.

The aim of chemotherapeutic studies is the search for specifics. A group or polytropic specific, as that of salvarsan for different spirochætes and even trypanosomes as well, is to be hailed as a distinct advance; the ultimate aim of chemotherapy, however, is the discovery of a monotropic chemical or one highly specific for a certain micro-

parasite. For example, it is highly probable that further modification of salvarsan, tending to increase its spirochætidal properties in general and for *Treponema pallidum* in particular, will greatly increase its value in the treatment of syphilis.

From the standpoint of experimental chemotherapy, drugs may be said to possess two properties of paramount importance, namely, an organotropic, or influence for the body cells which usually expresses itself in certain dosage by toxic effects, and, possibly a parasitotropic or destructive effect upon some animal or vegetable microparasite in the living animal. The aim of the experimental chemotherapeutist is to lower the former and enhance the latter, so that the chemical under study may safely be given in such dosage as will be effectively parasitotropic in high dilution in the body fluids. Under these conditions the chemical may prove beneficial in the treatment of a disease, not only by reason of its parasitotropic or direct destructive effect upon a particular microparasite, but also by reason of stimulating the production of antibodies by the body cells or by inducing a leucocytosis; by facilitating phagocytosis and by pharmacological activities on the respiratory, cardiac, heat and other vital centres. For example, salvarsan may prove of value as a hæmatinic, not only in the anæmia of syphilis, but likewise in anæmias of non-syphilitic origin; according to our experiments ethylhydrocuprein and cinchona compounds in general appear to influence the pneumococcus not only by reason of their pneumococcidal power but by inducing leucocytosis and stimulating phagocytosis as well possibly by a pharmacological influence upon the higher nerve centres.

In the rational development of the chemotherapy of bacterial and protozoön infections it is desirable, if possible, to commence experimental work with a substance or substances possessing some definite destructive effect upon the microparasite under study. This parasitotropic effect may be apparent only in test-tube experiments, in which event an effort is made to lower the toxicity or organotropism of the substance with, or even without, an increase of its parasitotropic power, in order that it may be administered in such quantity as will exert in the living animal an inhibitory or killing action on the microparasite under study without injury to the host.

In chemotherapeutic studies it is highly desirable to work with a base which offers most hope for successful development, and, in the present state of our knowledge, chance or accidental discovery must play an important rôle in the discovery of the "lead." Substances are selected or prepared upon as systematic a basis as possible and tried

out by actual experiment; those yielding encouraging results are then subjected to various systematic modifications with experimental trial of the new compounds. In this manner chemotherapeutic research proves to be costly and laborious, as amply demonstrated by the prolonged and costly series of experiments directed by Ehrlich, resulting in the discovery of salvarsan and related compounds.

In the discovery of "leads" and the study of new compounds, animal experiments are of primary importance, not only because these are the sole means of determining the organotropic or toxic effects of the compounds, but because they are the sole means of determining the actual parasitotropic or therapeutic effects. In chemotherapeutic studies in any particular disease it is highly desirable that the causative micro-parasite be capable of artificial cultivation or at least prove transmissible to a lower animal; furthermore, it is desirable that the micro-parasite yield a uniform infection of the experimental animals of not too severe a character; produce definite lesions easy of detection and study and as far as possible similar to those found in man, or cause the death of the animal in a given period of time. For studies in bacterial chemotherapy virulent cultures of the pneumococcus are admirably adapted for work among mice and rabbits, although other micro-organisms as the staphylococci, streptococci, tubercle bacilli and others may be employed. As previously stated, chemotherapeutic studies in bacterial infections may be conducted on a definite or narrow scale with the microorganism of one disease, as in tuberculosis, or upon a wider scale as the search for a synthetic chemical possessing more general bactericidal properties. For example, chemotherapeutic studies in syphilis have shown that a trypanosome may be used as the test microorganism; in bacterial chemotherapy we are using virulent strains of pneumococci and staphylococci in most of our work, although it remains to be determined whether a compound showing a high bactericidal power *in vitro*, or even *in vivo*, on one microorganism, as *B. typhosus* or the pneumococcus, will show a similar effect upon the microorganisms of other diseases, as in tuberculosis or anterior poliomyelitis.

In chemotherapeutic studies in bacterial infections, test-tube experiments may be said to possess a definite value in preliminary orientation in the development of "leads," in the study of new compounds as they are produced and in the development of monotropic drugs. Experimental data at hand tend to show that substances possessing a high bactericidal activity *in vitro*, and particularly in a menstruum of fresh sterile serum, are more likely to exert an inhibitory or bactericidal

action *in vivo* than substances which are less active. For example, Morgenroth's ethylhydrocuprein exerts a very high bactericidal action on the pneumococcus *in vitro* and is likewise effective to some extent *in vivo*; other cinchona derivatives, including certain salts of quinine possessing more or less bactericidal value *in vitro*, are likewise effective to a certain degree *in vivo*. We have also found that arsenobenzol possesses a high degree of parasitotropic activity on *T. equiperdum in vitro*, and, as well known, this drug exerts the best parasitotropic effects *in vivo*. Unfortunately, however, as previously stated, other substances that are highly bactericidal *in vitro*, as the mercurials, also possess a high degree of toxicity for the living animal, and all efforts of the chemotherapeutist have so far failed to lower materially the toxicity of these compounds. I have given elsewhere a more complete discussion of the relation of *in vitro* tests to the problems of the chemotherapy of bacterial infections with a comparative study of various methods based upon work with the pneumococcus.<sup>1</sup>

As previously stated, the problem of the chemotherapy of bacterial infections is proving more difficult than that of protozoön infections. At the present time it may be stated that a start has been made, but so far researches have not yielded a drug of proven clinical value. Morgenroth's discovery of the pneumococcidal value of optochin (ethylhydrocuprein) constitutes a distinct advance, but is not of proven practical value. In our opinion this drug bears a relation to bacterial chemotherapy somewhat analogous to that presented by atoxyl toward the chemotherapy of protozoön infections a few years ago, and at the time when Ehrlich decided to employ it as a base and lead for his work with the arsenicals. More recently Koga has reported interesting and encouraging results in the chemotherapy of tuberculosis with a copper compound. Without much doubt further discoveries will be made, and a definite and specific chemotherapy of bacterial infections, as those produced by the pneumococcus, streptococcus, staphylococcus, gonococcus, *Bacillus typhosus*, *Bacillus tuberculosis*, *Bacillus lepræ* and others, is within the realm of possibility; it is quite certain, however, that these discoveries are not likely to be made by happy-go-lucky hit-or-miss experiments, but by the prepared mind and by careful, painstaking, prolonged and costly experiments and with the realization that much work must be done before definite results are obtained, and, that indeed individual efforts may not bear immediate fruit at all.

<sup>1</sup> Kolmer, J. A., Cohen, S. S., and Heist, G. D.: Various Methods for Determining the Bactericidal Action of Substances *in Vitro* and Their Relation to the Chemotherapy of Bacterial Infections. *Jour. Infect. Dis.* (in press).

## ACUTE OSTEOMYELITIS OF THE SPINE\*

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THE relatively few reported cases have led us to add the following observation of this interesting localization of acute osteomyelitis.

*History of Case.*—M. R. H., 90773, aged twenty-three, merchant, was admitted to the hospital on August 24, 1916, on account of acute urinary retention. No local cause being found for this condition, he was transferred to the medical service where he was examined by Dr. Schram. The patient looked very septic, the temperature was 104.2° F. (rectal) and pulse 120. He complained of pain over the lumbar region of the spine of a diffuse character. He said he had always enjoyed excellent health except for an infection of the right index finger, requiring operation one month before. Present illness began suddenly with pain in the back, radiating to the left side, and accompanied by high fever and severe night sweats for twelve days before admission.

Soon after the first examination noted above, he had a chill and sweat, the temperature rising to 105.4° F. (rectal) and continued so for the next twelve hours (Fig. 1). The first impression he made of some form of generalized sepsis was strengthened by the observation of the patient during the 24 hours following his admission. The examination of the spine at first had shown only diffuse tenderness over the lumbar and sacral regions, but during the last half of the first twenty-four hours there was retraction of the neck with marked rigidity of the entire spine and symptoms of meningeal irritation (Kernig sign present and suggestion of a Babinski sign and generally increased reflexes). No eye changes were found. Leucocytosis was 14,000. Lumbar puncture was done and pure pus escaped from the spinal canal. Up to this time the diagnosis had been a diffuse meningitis, but, when the staphylococcus aureus was found in pure culture in the fluid obtained by lumbar puncture, the question arose as to the source of the pus as the symptoms were entirely those of spinal irritation.

Radiographic examination showed an area of osteoporosis in the body of the third lumbar vertebra. His symptoms of meningeal irritation increased rapidly during the next twelve hours and

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\* Read before the Chicago Medical Society, November 15, 1916.

he was transferred to the surgical service of Dr. D. N. Eisendrath, who confirmed the findings of Dr. Schram and suggested further the possible presence of an acute osteomyelitis of the spine in the lumbar region, secondary to the infection of his index finger.

*Operation* (August 26, 1916).—Laminectomy for drainage of epidural abscess (lumbar region) due to osteomyelitis of third lumbar vertebra. Examination of patient under anæsthesia failed to show any rigidity or other evidence of perinephric abscess, but there was a sense of fluctuation on the left side of the spine in the lumbar region. An incision a little to the left side of the median line showed pus escaping from beneath the deep spinal

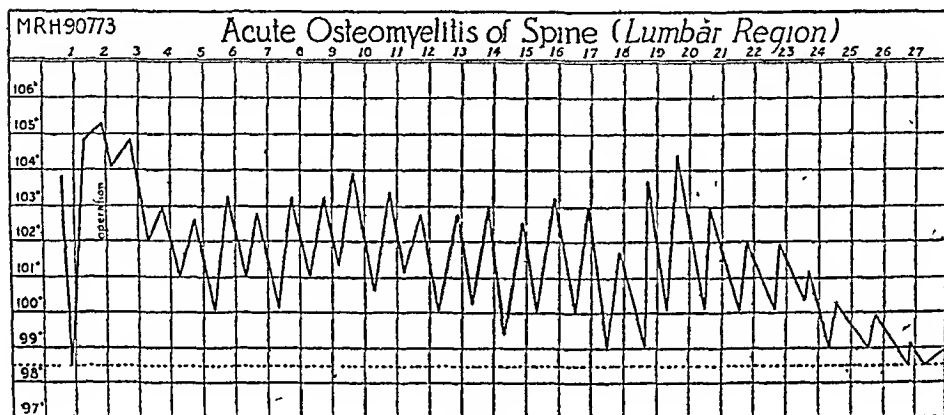


FIG. 1.

muscle (erector spinæ) apparently from the left side of the spinous process of the third lumbar vertebra. Upon reflecting the muscles from the laminæ of this vertebra—thick yellow pus was seen to escape from a space in the median line between the spines of the third and fourth lumbar vertebrae, *i.e.*, from within the spinal canal. The laminæ and spines of the third and fourth vertebrae (lumbar) were removed and the cauda equina was exposed. It was covered with reddish fibrinous material and completely enveloped in thick pus lying in the epidural space. There was an apparent walling off of the suppuration in an upward direction, but towards the sacrum there was free pus around the cauda. The vertebral bodies could not be seen, but the X-ray had shown a roughened condition of the third lumbar body and this was no doubt the source of the pus. Two gauze and rubber tissue drains were inserted at each end of the wound into the spinal canal and a rubber tube at the centre, the wound being closed in layers. Cover slips of the stained pus showed a staphylococcus. The course of the temperature is shown in Fig. 1.

On the morning following the operation the rigidity of the

## ACUTE OSTEOMYELITIS OF THE SPINE

neck and spine were absent. The reflexes were less active, the Kernig and other irritation symptoms much diminished. This decrease in the reflexes continued until they became normal, as at present time. For a time patient complained of pain and paræsthesiæ in lower extremities, but there were no objective findings.

*Remarks.*—The relatively small number of reported cases of osteomyelitis of the spine is probably because diagnosis is not made.

In many of the cases, the symptoms of the systemic infection completely overshadow those of the local disease. The most thorough review of the subject is that of Donati<sup>1</sup> in which he reports one case of his own and collected 55 cases published up to 1906. Kirmisson<sup>2</sup> found in 1909 the report of nearly a hundred cases, but he has no doubt included osteomyelitis of the sacrum, which Donati and the later publications have excluded, first because there is little likelihood of escape into the spinal canal and second because the disease is most frequently found in the lateral portions of the sacrum which embryologically correspond to the ribs. The majority of writers prefer to take up osteomyelitis of the sacrum in connection with the pelvis. Volkmann<sup>3</sup> up to 1914 collected 84 cases (including one from Payr's clinic). He believes cases of sacral osteomyelitis should be excluded.

It may be of interest to review some of the more important observations in regard to the disease. The largest number of cases occur between the tenth and twentieth year. Although trauma plays a rôle as an exciting cause, the most frequent etiological factor is the presence of a suppurative focus elsewhere, *e.g.*, furuncle, osteomyelitis focus, paronychia, etc. In fourteen of twenty-one cases collected by Donati and in twenty-four of thirty-five cases reported by Volkmann, the staphylococcus was found in pure culture.

The lumbar region is the one most frequently involved, according to Donati (twenty in fifty-six), while in the statistics of Volkmann the largest number are found in the dorsal region. As a rule several vertebræ are involved. The entire vertebral body and arch was the seat of the disease in a smaller number of cases than was the case of the body or arch alone. Involvement of the body is more often followed by invasion of the spinal canal and the development of peripleuritic and psoas abscesses than that of the arch.

The majority of cases (sixty-eight per cent.) run an acute course and the mortality is correspondingly higher in this class than in the

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<sup>1</sup> Archiv für klinische Chirurgie, 1906, vol. lxxix, p. 1110.

<sup>2</sup> Presse médicale, 1909, No. 38.

<sup>3</sup> Deutsche Zeitschrift für Chirurgie, 1914, vol. cxxxii, p. 445.



subacute cases. Donati found that in six of twelve deaths in the acute form, death was due to the invasion of the spinal canal. The delirium and other symptoms of generalized sepsis are often so marked that death occurs before a diagnosis is made.

In the less severe form, the symptoms vary greatly. Severe pain over the affected vertebra associated with rigidity of the spine is of the greatest value in making a diagnosis. The same is true of localized oedema and tenderness. Of aid in recognizing the presence of an acute pyogenic focus in the cervical vertebra are rigidity of the neck, neuralgias in the occipital region and early signs of compression. In the dorsal spine the pus is very apt to gravitate in a forward direction, resulting in the formation of a peripleuritic abscess. In a similar way a suppurative inflammation of the psoas muscle may be the result of osteomyelitis of the lumbar region. Severe pain due to pressure on the nerve roots rarely occurs except in the cervical region. The most frequent symptoms then are pain in the back, rigidity, oedema and swelling. The X-ray is a great aid if the symptoms as in our case do not enable one to localize the disease. The same is true of lumbar puncture if one obtains pure pus as in the case reported by us. In those cases in which the general symptoms predominate, one must exclude typhoid, acute rheumatic spondylitis and meningitis.

The escape of the pus into the spinal canal may result in (a) an extradural abscess with symptoms of meningeal irritation as in our case, (b) in pressure upon the cord with symptoms of compression corresponding to the level involved, (c) a purulent meningitis. The mortality of osteomyelitis of the vertebra is highest when the cervical region is involved and least in the dorsal region and at a point between these two extremes in the lumbar region. Operative interference is indicated as soon as a diagnosis is made. Unfortunately the condition has been recognized in only one-third of the published cases according to Volkmann. Simple incision and drainage may suffice, but it is best to do a laminectomy as in our case so as to provide for free drainage. If the focus in the bone can be found its removal is permissible if the risk of the operation is not greatly increased; otherwise it is best to be conservative and to wait for sequestration. Healing usually occurs without the formation of a kyphosis. If a peripleuritic or psoas abscess be recognized early incision and drainage are indicated. A stereoscopic röntgenogram of the chest combined with fluoroscopy should be made whenever the dorsal region is involved. No doubt the number of reported cases will increase rapidly as the disease begins to be recognized.

# THE SIGNIFICANCE OF GIANT-CELLS IN BONE LESIONS

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THE significance of the presence of giant-cells in bone lesions, particularly the type cell classified under the terms "foreign body, scavenger (Barrie), multinucleated, myeloplax, or osteoclast," is still an open and debatable question among many workers interested in bone surgery and pathology.

While differing opinions are expressed, it may be stated: probably a majority accept the view that when numerous cells of the above-mentioned type are found in bone lesions, they signify a benign condition, provided the other cells composing the histopathologic picture give no evidence of malignant change.

The varying perceptions that prevail among those interested in the subject may be summed up as follows: One group maintain that the presence of such giant-cells in lesions is an evidence of reactionary inflammatory change only; their presence should be disregarded in so far as tumor formation is concerned. These investigators believe all evidence points to the conclusion that they have no part in actual neoplastic growth. Another group oppose this view and contention, and insist that the giant-cells commonly found in certain bone lesions and tumors are an integral part of the mass. They state that the cells form a portion of, and may determine the character of, a neoplasm. This group refuses to accept other than neoplastic significance for the giant-cells when their presence is noted in certain pathologic processes in bone.

And, finally, there remain a number of observers unable to decide at the present time which may be the correct interpretation.

Pathologists also express opposing views in their writings and teaching regarding the origin of the giant-cells. Divergent opinions in this respect are very pronounced.

Another active subject of contention and debate is the function the cells possess. This lack of agreement among pathologists, and their apparent inability to definitely decide the rôle all giant-cells play in pathologic processes and the exact position that should be assigned them has led to considerable confusion. The clinical surgeon especially has felt the need of a more clearly defined opinion upon which

might be based future operative procedures. At the present time, many surgeons more or less discard and disregard the microscopic diagnosis of a giant-cell content. They rely upon their own interpretation of the clinical, X-ray, operative, and gross pathologic appearances of the lesion, as a whole, for guidance and decision in their efforts at operative therapeutic cure.

This attitude is perhaps unfortunate. In a great many instances a fairly conclusive and correct diagnosis may thus be made, but in order to obtain complete and positive data, a microscopic finding, confirmatory or otherwise, is always desirable and sometimes essential.

Bearing these facts in mind, a consideration and discussion of the origin, function, and significance of giant-cells seems justified at this time, and particularly the relation and position they occupy in the lesion described by different writers under the following terms: (1) Myeloid sarcoma; (2) medullary giant-cell sarcoma; (3) myeloma; (4) medullary giant-cell tumor (Bloodgood); (5) chronic hemorrhagic osteomyelitis (Barrie).

*Origin of the Giant-Cells.*—Workers noted in the realms of pathology still hold dissenting views regarding the origin of multinucleated giant-cells. It has been recognized for many years that sterile foreign particles kept in soft tissues attract numerous endothelial leucocytes to them. Microscopic studies have shown that the leucocytes may fuse in their efforts to surround and dispose of such substances. In this way multinucleated giant-cells are formed. The observation of Zeigler and others, of the behavior of the endothelial leucocytes in this manner, and their fusion into giant-cells, gave rise to the term "foreign body giant-cell."

It is not yet a generally accepted fact that this is the only source of origin of such type cells. Adami, quoting Von Hauseman and accepting his classification, attempts to distinguish between what is termed the myeloplax, or osteoclast, and the so-called multinucleated foreign body, or scavenger giant-cell. He insists that the so-called myeloplax, or osteoclast, is of myeloblastic origin, but agrees that what are usually termed foreign body giant-cells arise from endothelial leucocytes. Mallory, as a result of his independent studies, experiments, and investigations, advanced the opinion in 1910 that the so-called myeloplax, or osteoclast, of Kölliker, and the multinucleated foreign body giant-cell is one and the same histologic entity—that is, the cells in all respects respond to the same criteria, and conform identically to all staining methods. In his later research and studies, he has demonstrated that cells of true myeloblastic origin give bio-

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chemical reactions apparently not obtainable from the so-called myeloplax, or osteoclast. He concludes that the latter-named cells are, in fact, formed from the fusion of endothelial leucocytes.

Many modern writers now agree that the commonly known foreign body giant-cell has its origin in this way. Perhaps a majority do not concur in the opinion that the so-called myeloplax or osteoclast originates from the same source. Some writers assert they arise from osteoblasts, and others that they are the product of the bone-marrow. Another theory regarding giant-cell origin is that they are formed through rapid nuclear multiplication within the cell body.

The main characteristics of the giant-cell termed myeloplax, or osteoclast, multinucleated, scavenger, and foreign body may be roughly classified as follows: (1) Nuclei may range between 2 and 200. (2) Rather uniform size and shape of nuclei. (3) Absence of mitosis or mitotic figures. (4) Arrangement of nuclei may be either central, peripheral, unipolar, or scattered over the cytoplasmic mass. (5) Vacuolation and degenerated areas in cytoplasm are more frequently seen in large cells containing many nuclei.

One may occasionally observe apparent coalescing of two giant-cells to form a very large cell.

After careful study of numerous sections taken from bone-lesions and induced pathologic processes in soft tissues, it has seemed to the writer impossible to differentiate as to which cells might be termed myeloplax, and which foreign body giant-cell.

*True Tumor Giant-Cells.*—There is apparent unanimity of opinion regarding the origin, function, and significance of the true tumor giant-cell termed by von Hauseman, and adopted by Adami and others, "parenchymatous giant-cell." This type is observed on the rarest occasions in bone lesions. When its presence is noted in any pathologic process, a high grade malignancy is assured. It is well described by Stewart as follows: "Here the nuclei are extremely irregular in size and shape, often presenting lobes and indentations, while most of them are large size; not infrequently nuclei of enormous size are met with, and in such cases the giant-cell may be mononuclear. The number of nuclei seldom exceed six, and most of the cells form one to four only. They usually lie clumped together in the cell so that it is often difficult to determine precisely how many are present.

"Mitosis within the giant-cell is of common occurrence and very frequently this is of the multipolar type. Vacuolation is rarely seen."

Stewart's description is very clear. It differs in large degree from the appearance of the giant-cell common to bone lesions.

The pathologic process in bone possessing more than passing interest to the surgeon is the lesion described under these terms: Medullary giant-cell sarcoma; myeloid sarcoma; myeloma; medullary giant-cell tumor (Bloodgood); chronic hemorrhagic osteomyelitis (Barrie).

The giant-cell content in this lesion has heretofore been the large factor in reaching histologic diagnostic conclusions. The gross appearance these tumor-like masses present is now generally conceded to resemble hemorrhagic granulation tissue.

The opposing views held regarding the significance of giant-cells found in this bone lesion are, perhaps, best stated by Adami on the one hand and Mallory on the other. Adami records the following opinion: "For myself, I cannot but hold that they are specific constituents of the tumors, every whit as much as the osteoclasts of Howship's lacunæ are specific constituents of normal bone-marrow. I would lay down, indeed, that the bone-forming and bone-destroying cells are the primary constituents of the bone-marrow, giving rise to myelomas of the first order, and that the hemal mother cells are secondary, giving rise to myelomas of the second order which indeed may originate elsewhere wherever these hemal mother cells have a normal existence."

Mallory sums up the diametrically opposed view as follows: "They are foreign body giant-cells similar to the osteoclasts of normal bone, and are due to the fusion of endothelial leucocytes attracted into the tumor by the presence chiefly of lime salts, which they dissolve and remove. They signify, usually, disintegration of bone. The tumor containing foreign body giant-cells should be classified according to the nature of the other cells present in the tumor; the foreign body giant-cells should be disregarded. They do not signify either rapid growth or malignancy."

Ziegler and others have maintained that the presence of this type giant-cell does not form an essential characteristic of a peculiar type of tumor. They are accidental, resulting from continued irritation.

The writer has been able to make experimental studies which seem to demonstrate that the significance of the giant-cells is fully accounted for when their scavenger function is recognized. Their formation, existence, and function are apparently dependent upon the presence in the tissues of alien products that are inactive, apparently non-infective and non-purulent.

Observation and study of many bone lesions of the type described by the writer as chronic hemorrhagic osteomyelitis, in which areas are often found containing a large giant-cell content, leave no doubt (in the writer's opinion) of the correctness of Mallory's views and teaching.

## SIGNIFICANCE OF GIANT-CELLS IN BONE LESIONS

Experimental reproduction of so-called medullary giant-cell sarcoma, which may be brought about at will by mechanical insult to tissues, further confirms the contention that such giant-cells are not tumor-forming cells, and such lesions are not autonomous growths.

Giant-cells of the scavenger type are sometimes observed in true neoplasms in bone. They should be regarded as incidental. Their presence in bone tumors usually signifies a low grade malignancy.

The tumor-like formation of proliferative granulation tissue masses that form the gross lesions termed "medullary giant-cell sarcoma, myeloid sarcoma, myeloma, medullary giant-cell tumor, and chronic hemorrhagic osteomyelitis," is due to its environment in cancellous bone. The true nature of this tissue cannot be gainsaid, either in its gross appearance or histologically. The masses filling destroyed bone areas are the real evidence of nature's effort at regeneration and restoration. They should not be regarded as neoplasms. They are masses of hemorrhagic granulation tissue formed in response to inflammatory stimuli. Initial cancellous bone destruction paving the way for these lesions may be due to trauma, to change following mild non-suppurating infections, or to some metabolic inflammatory disturbance.

Efforts of the host to restore the complex bony defect begin first in the formation of embryonal vascular granulation tissue highly proliferative in character. Overproduction of this structure for a given need is a common observation. When this occurs, pressure is exerted on the surrounding delicate trabeculae, causing nutritional inhibition, rarefaction, and destruction from pressure necrosis. In this way a vicious circle is established.

Slow progressive increase in size of the lesion may be expected in this stage. It is also during this period that giant-cell formation and activity is greatest.

Increased stimulation, brought about by certain chemotactic properties in the blood, produces a fibrous metaplasia of the granulation tissue. The terminal, or curative stage, may then be said to have commenced. The fibrosis means contraction and retraction of structure and thus removal of pressure upon bony septa, and the prevention of further bone tissue destruction, and, finally, conversion of the hemorrhagic granulation tissue into structure fibrocystic in character.

The first stage of the lesion should be recognized as a chronic (proliferative) hemorrhagic osteomyelitis. The final stage may very appropriately be termed a fibrocystic osteomyelitis.

Quite illuminating is the result of an experiment shown in Figs. 6 and 7. The study for the picture was produced as follows: Under

surgical aseptic technic, a piece of sterile gauze was inserted through an incision in soft parts, the wound then closed and sealed. Some weeks later reopening over old scar and removal of gauze and its contained material was accomplished. The gauze was found surrounded with, and embedded in, hemorrhagic granulations. The illustrations show a high- and low-power cellular picture, quite interesting in that the giant-cells resemble so-called myeloplaxes, scavenger, or foreign body cells enmeshed in gauze fibres.

A similar cellular picture, excluding the gauze fibres, may be observed in bone lesions described as myeloid sarcoma, medullary giant-cell sarcoma, myeloma, medullary giant-cell tumor, and chronic hemorrhagic osteomyelitis.

Other experiments have demonstrated that giant-cells may be formed in any of the tissues in the body where a hæmal capillary circulation is active, similar in their histologic aspects to those credited with producing medullary giant-cell sarcoma, provided a suitable irritative agent is present.

It is difficult in the light of our present knowledge to understand why the presence of these cells in bone lesions should be considered evidence of malignancy, or that they should be credited with producing autonomous growth. There is no doubt they do indicate a mild inflammatory reaction. These characteristics of the cell have been known for a long time, and have been observed in tissues containing sutures, ligatures, and other sterile foreign substances. Their function may be regarded as truly beneficent and free from exerting any malign influence.

The relation of giant-cell distribution to type structure has been rather constant in bone lesions, termed by the writer "chronic hemorrhagic osteomyelitis." They range about as follows: (1) In areas exhibiting marked cellular necrosis—no giant-cells. (2) Areas exhibiting marked fibrosis—very few or no giant-cells. (3) Areas of regenerating vascular granulation tissue adjoining the bone borders surrounding the lesion—few to moderate number of giant-cells. (4) Areas composed of organizing and organized hemorrhagic masses—numerous giant-cells covering entire microscopic field, and occupying vascular spaces.

The practically constant findings in numerous instances of a greatly increased number of giant-cells in areas of recent and ancient hemorrhage lead to the assumption that probably herein lies a great attraction and stimulus for giant-cell formation, and the opportunity for the performance of their function as scavengers. This structure, perhaps,

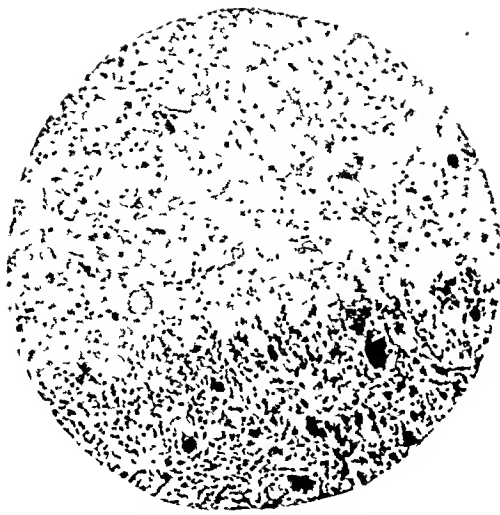


FIG. 1.—Chronic (proliferative) hemorrhagic osteomyelitis. Taken from an area in lesion showing cellular necrosis. Note absence of scavenger giant-cells in necrotic area (low power).

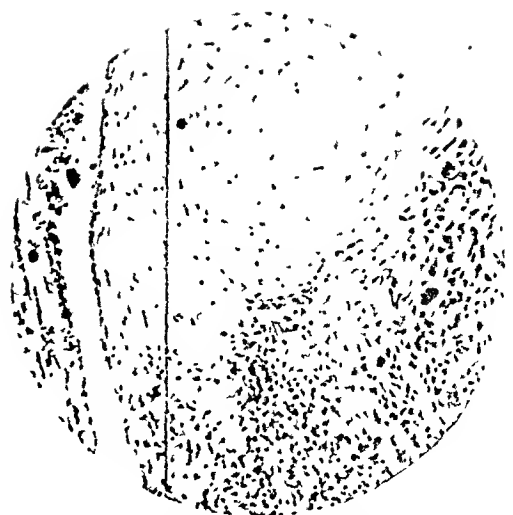


FIG. 2.—Chronic (proliferative) hemorrhagic osteomyelitis. Shows marked fibrosis and fibrosing granulation tissue. Note few scavenger giant-cells, and none where marked fibrosis is apparent (low power).

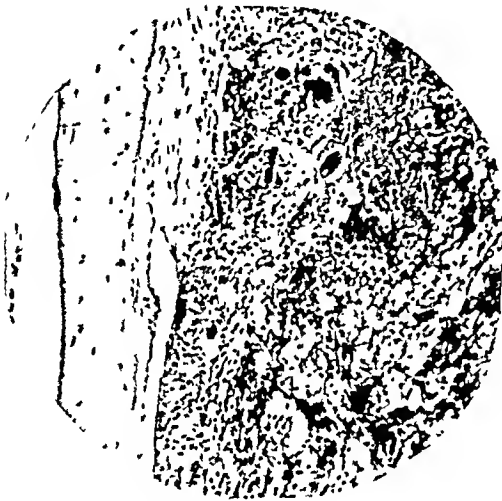


FIG. 3.—Chronic (proliferative) hemorrhagic osteomyelitis. Taken from an area adjoining bone surface. Note heterogeneous cellular picture (low power).



FIG. 4.—Chronic (proliferative) hemorrhagic osteomyelitis. Section taken from heart of hemorrhagic mass. Note scavenger giant-cell content (low power).



FIG. 5.—Chronic (proliferative) hemorrhagic osteomyelitis. High power picture taken from same section as Fig. 4, to show in detail scavenger giant-cells.

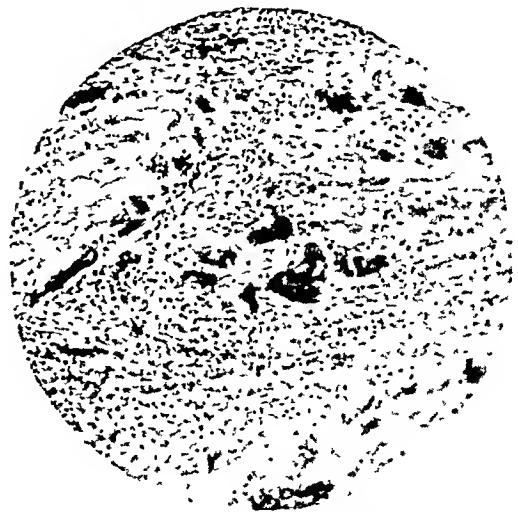


FIG. 6.—Experimentally produced lesion simulating so-called giant-cell sarcoma. Note scavenger giant-cells in granulation tissue cellular picture, intertwined in which may be seen gauze fibres (low power).



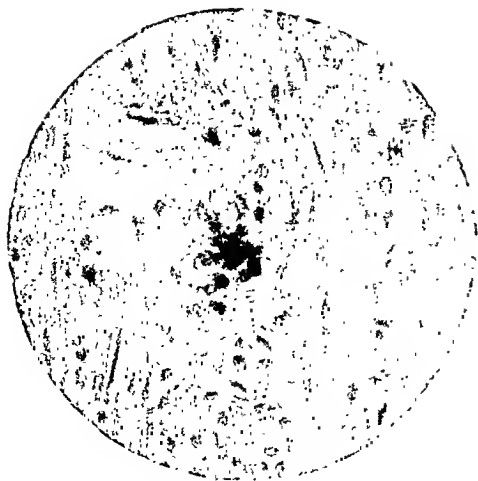


FIG. 7.—High power, showing character of scavenger cell seen in Fig. 6.



FIG. 8.—True neoplastic growth, a fibrosarcoma of bone, low grade malignancy, showing the giant-cells of scavenger type similar to those of chronic (proliferative) hemorrhagic osteomyelitis, and to the experimentally produced lesion seen in Figs. 6 and 7 (low power).



FIG. 9.—High power picture, fibrosarcoma, low grade malignancy, showing scavenger giant-cell. Taken from same case as Fig. 8.

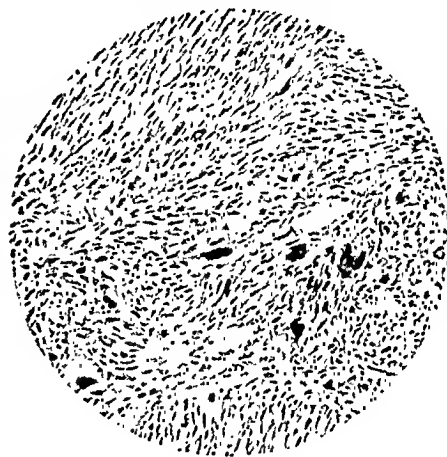


FIG. 10.—True neoplastic growth. Fibrosarcoma of bone, highly malignant. Note the absence of scavenger giant-cells and presence of true tumor giant-cells (low power).

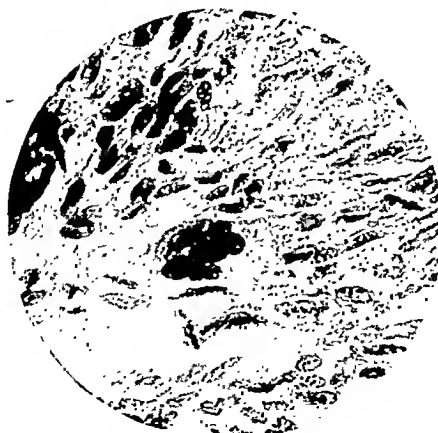


FIG. 11.—High power picture of same tumor as shown in Fig. 10. Note cellular disarrangement and nuclear distortion in giant-cell.

## SIGNIFICANCE OF GIANT-CELLS IN BONE LESIONS

offers a greater stimulus than the presence of lime salts from disintegrated bone, as suggested by Mallory. Many of the cells contain pigment.

In papers published in 1912 and 1913, the writer first called attention to the inflammatory origin and chronic character of lesions in the long bones, generally described as medullary giant-cell sarcoma, myeloid sarcoma, myeloma, medullary giant-cell tumor. Subsequent papers published in 1914 and 1915 added further confirmation of the earlier view. Accumulated evidence, study and experimental investigation, add proof to our conclusions previously announced that the lesion does not belong to the neoplastic group. The affection must be regarded as the product of an inflammatory reaction.

The presence of numerous giant-cells within the pathologic mass and upon which great stress has heretofore been made as evidence of neoplastic growth is really the index of a mild inflammatory process. No proof has ever been given that the giant-cells, *per se*, have any effect upon true tumor growth. Abundant evidence is to be had regarding their connection with processes of a mild inflammatory character. It is only necessary to bear in mind that the pathology of a localized so-called rarefying osteitis gives a picture similar to the early stage of what has been named giant-cell sarcoma.

"Rarefying osteitis" is described by Delafield and Prudden as follows: "When this form of inflammation occurs in cancellous bone tissue the marrow is red or gelatinous and the bony septa disappear altogether, so that in extreme cases there may be, instead of cancellous bone, a mass of granulation tissue."

It is not difficult, indeed it is quite easy, to experimentally produce a lesion in the long bones that exactly resembles a so-called medullary giant-cell sarcoma, or tumor, both in its gross and histologic aspects. The method is carried out as follows: Under careful aseptic surgical technic, an opening is made through tissues into cancellous bone, preference being given to the lower end of the femur or upper end of the tibia. A portion of cancellous tissue is removed and the cavity thus made loosely filled with sterile material, preferably gauze, or some of the removed cancellous bone may be replaced in the cavity surrounded with gauze. The wound is then closed and sealed. On reopening some weeks or months later a typical picture of so-called giant-cell sarcoma may be presented. Experimental work of this character offers substantial support of the inflammatory origin and progress of these lesions.

Adami and Bland Sutton, recognizing that the so-called medullary giant-cell sarcomata were benign in character, and believing the giant-

cells they contained were of myeloblastic origin, in later works described the lesion as myeloma. The term myeloma does not seem altogether fortunate, because we already have a well-defined and generally recognized tumor bearing the name that gives its own characteristic picture, quite different from the lesion under consideration. Mallory's evidence that so-called myeloplaxes are of endothelial origin would seem to rule out the term.

Bloodgood, as a result of careful observation, large experience, and exhaustive study of all types of bone lesions, also grasped the fact that malignancy was not a feature of this pathologic process. He suggested the term "medullary giant-cell tumor" in 1912. The term giant-cell tumor, if applicable here, is equally so in other parts of the body where granulation tissue has room to proliferate and spread, and embedded in which alien sterile particles preside.

The presence of granulation tissue masses presupposes an inflammatory process of mild degree. As it seems impossible of proof that the giant-cells have anything to do with tumor growth or tumor formation and all evidence points to their function as scavengers, or foreign body cells, brought forth for a definite purpose, and disappearing when that purpose is fulfilled, it does not seem they may be effectively classed as tumor cells.

Neither can the granulation tissue masses that compose these lesions rightly be termed tumors or neoplasms. The writer desires to emphasize the opinion expressed in earlier papers that this bone lesion should be grouped with the surgical diseases classified as inflammations. From the clinical picture and gross and microscopic pathology it presents, the term "chronic (proliferative) hemorrhagic osteomyelitis" is, perhaps, more exact and correct than the other terms now in use.

In a future paper, the writer will attempt to take up in detail the etiology concerning this particular inflammatory pathologic process. An effort will also be made to bring out more clearly the position that should be assigned to trauma, mild infections, and irritative metabolic changes as factors in its production.

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# A COMPOSITE STUDY OF THE COELIAC AXIS ARTERY

BY BENJAMIN LIPSHUTZ, M.D.

OF PHILADELPHIA

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THE many vascular variations which are constantly observed in the dissection of adult cadavers show a distinct tendency to group themselves into definite anatomic types. The epoch-making work of Ruge in 1883 contributed greatly to our knowledge of arterial variations. It was his conclusion that these variations tend to fall naturally into distinct groups. Hitzrot's study of the axillary artery, Bean's of the subclavian, and that of the writer on the femoral support Ruge's conclusions.

The first paper on the study of the blood vascular tree presents a consideration of the femoral artery. In this the second paper of the series, a study of the coeliac axis artery is presented. The records which underlie this study were made from student and personal dissections at the Daniel Baugh Institute of Anatomy of the Jefferson Medical College. The dissections of 83 cadavers were recorded; 67 male white, 8 female white, 6 male negro, and 2 female negro.

In the study of the femoral artery, mention is made of the occurrence of numerous minor arterial variations not entirely in accord with the described anatomic types; yet the cases studied show a clear tendency to group themselves into distinct anatomic types. Analogous results are now found in the study of the coeliac axis artery. The classification of the coeliac axis artery is based on the origin and distribution of the gastric, splenic and hepatic arteries. Section A of this paper contains a description of the various types. Section B embraces a description of the gastric, splenic and hepatic arteries and their respective branches. Section C summarizes and discusses the results of the present study.

## SECTION A—DESCRIPTION OF TYPES

TYPE I.—This type (Fig. 1) is found in 75 per cent. of the cases classified. It embraces those subjects in which the coeliac axis is the common trunk of origin for the gastric, splenic and hepatic arteries.

In 24 of the cases studied the gastric artery is the first branch of the celiac axis and it arises eleven times from the celiac axis close to the aorta. The gastric artery takes origin six times from the summit of the celiac axis. The splenic artery in two of the cases observed is the first branch of the celiac axis. In 21 of the subjects classified, the gastric, splenic and hepatic arteries arise from the celiac axis at the same level.

The celiac axis varies in length from 1 to 3 cm. and is not infre-

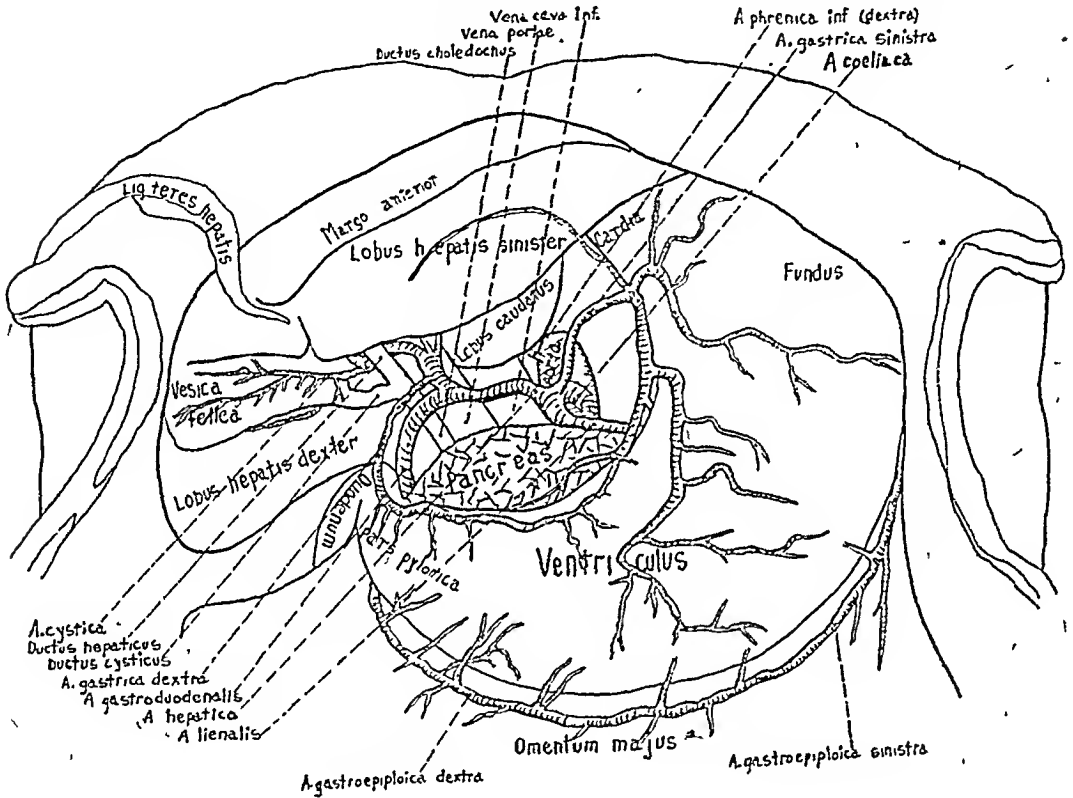


Fig 1.

FIG. 1.—This arrangement of the branches occurs in seventy-five per cent. of the cases classified.

quently partly covered at its origin by the diaphragm. It is worthy of note that in eight subjects of this group both the celiac axis and its branches are poorly developed; these subjects present no additional vessels from the adjacent arteries to compensate for this apparent deficiency in blood supply. There are in this type (Fig. 1) 53 male white, 4 female white, 3 male negro, and 1 female negro subjects. This is the type which is described in the German, English and French anatomical text-books most universally used.

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**TYPE 2.**—This type (Fig. 2) is present in 15 per cent. of the cases classified. In this group the hepatic and splenic arteries both arise from the cœliac axis artery. The gastric artery occurs as a separate branch directly from the abdominal aorta, and in every case observed it is cephalic to the origin of the cœliac axis. The cœliac axis artery divides at its summit into the splenic and hepatic arteries. There are in this group 11 subjects in all—9 male white, 1 female white, and 1 male colored.

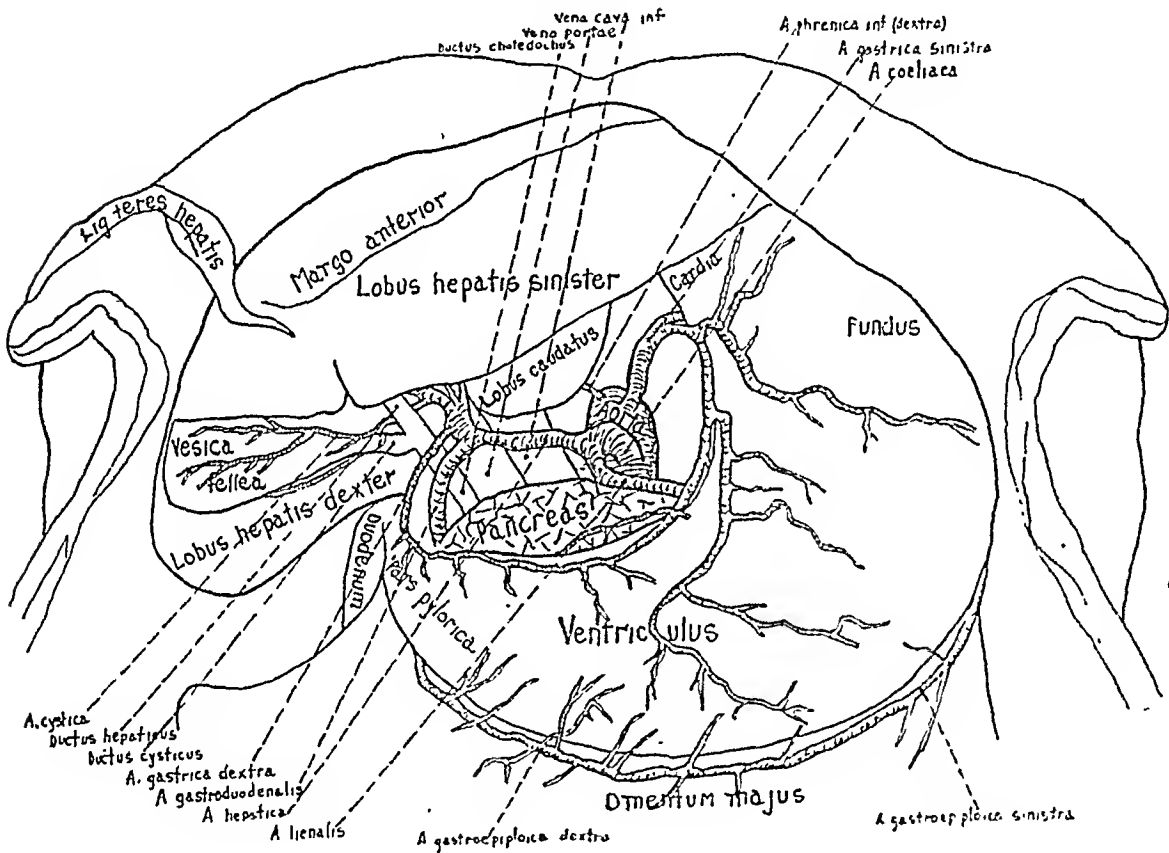


Fig 2

FIG. 2.—This type occurs in fifteen per cent. of the cases classified.

**TYPE 3.**—This type (Fig. 3) is present with slight variations in 6 per cent. of the subjects studied. In this type the gastric and hepatic arteries take origin from the cœliac axis artery. The splenic artery arises as a separate branch from the abdominal aorta. The hepatic artery in 3 subjects of this group is represented by two vessels each of which has a separate origin from the cœliac axis artery. There are of this type 5 subjects; 3 male white, 2 female white, and 1 male negro.

TYPE 4.—This type (Fig. 4) occurs in 4 per cent. of the cases classified. The cœliac axis in this group is the trunk of origin for the gastric and splenic arteries. The hepatic artery occurs as a separate branch directly from the abdominal aorta.

SECTION B—DESCRIPTION OF BRANCHES

*A. Gastrica Sinistra.*—This vessel is the smallest of the three branches of the cœliac axis. It, however, is considerably larger than the right gastric (pyloric) artery. It arises in 15 per cent. of the cases observed as a separate branch of the

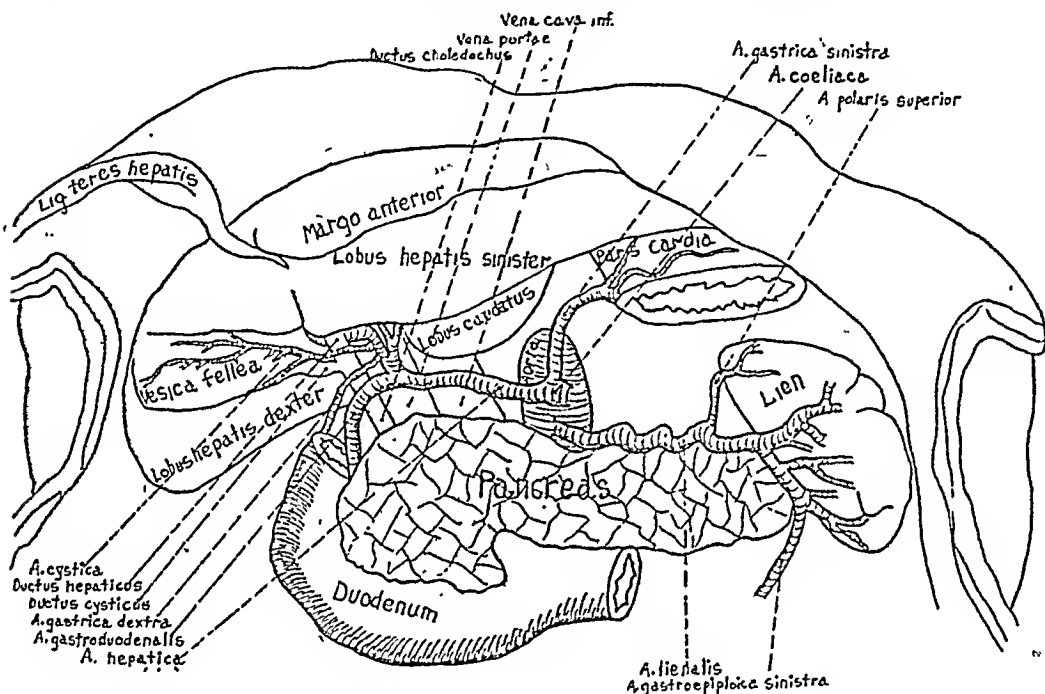


Fig. 3.

FIG. 3.—This arrangement of the branches occurs in six per cent. of the subjects studied.

abdominal aorta, and its point of origin is always cephalic to the origin of the cœliac axis artery. As it courses between the two layers of the lesser omentum, along the lesser curvature of the stomach, it is found in 35 per cent. of the subjects studied as two parallel stems. The site of division of the left gastric artery into a double vessel varies from one and a half to three cm. from its origin. In no case observed is the left gastric artery present as a double vessel at its origin. It occurs as a single vessel along the lesser curvature of the stomach which gives origin to the branches passing downward over both surfaces of the stomach in 65 per cent. of the cases classified. The left gastric artery occurs six times in a trunk common with the hepatic. In two of the subjects observed, it is present in a trunk common with the splenic artery. In one subject it takes origin from the abdominal aorta in a trunk common with the hepatic and superior mesenteric arteries; the splenic artery arising as a separate branch directly from

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the aorta and taking a circuitous route looping around the left gastric artery to gain its usual site and distribution.

The oesophageal rami are unusually large and well marked in 30 per cent. of the subjects studied. In three bodies observed, they are found as branches of the right inferior phrenic, and four times as branches of the hepatic branch of the left gastric. The cardiac rami vary in number and size and are usually not as well marked as the oesophageal rami. In 8 of the cases classified they are present as branches of the hepatic branch of the left gastric.

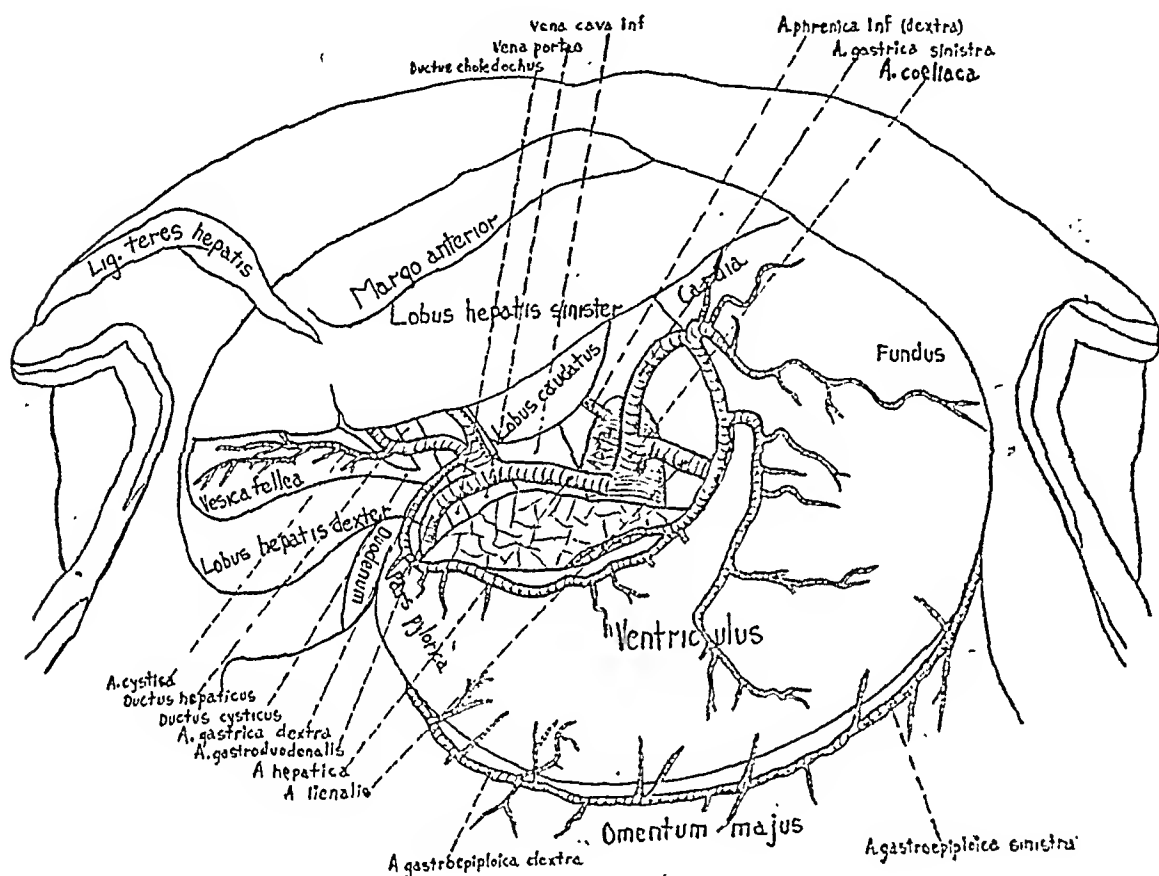


Fig 4.

FIG. 4.—This type is present in four per cent. of the cases classified.

A hepatic branch of the left gastric artery is found present in 35 per cent. of the subjects studied. This vessel varies both in size and in its anatomic distribution. It passes upward between the two layers of the lesser omentum to the inferior (visceral) surface of the left lobe of the liver in 16 of the cases observed. It is distributed as a branch to the transverse (portal) fissure 11 times and 3 times to the posterior surface of the liver and the oesophagus. It not infrequently gives origin to a number of twigs to the cardiac end of the stomach. This vessel in those cases in which it gains the portal fissure of the liver and in its distribution constitutes a left hepatic artery does not, however, replace the left hepatic which is present and well developed.

*A. Lienalis (Splanic).*—This vessel is the largest of the three branches of



the cœliac axis. The splenic artery arises from the cœliac axis in 92 per cent. of the subjects studied. It occurs 6 times as a separate branch directly from the aorta. In 15 per cent. of the cases classified, it takes origin from the abdominal aorta in a common trunk with the hepatic. In two bodies observed it is present in a common trunk with the left gastric.

In 67 per cent. of the cases classified this vessel is large and presents numerous tortuosities as it pursues its more or less transverse course from right to left along the upper border of the pancreas accompanied by the underlying splenic vein to gain the spleen. In 33 per cent. of the cases classified, this vessel is straight or only slightly tortuous. The splenic artery at its termination divides into two or three large terminal trunks, which break up into 6 to 10 branches before they enter the spleen. There are three terminal branches in 72 per cent. of the subjects classified; A. polaris superior, A. terminalis superior, and A. terminalis inferior; the two latter vessels enter the hilum of the spleen. In 28 per cent. of the subjects there are two terminal branches; A. terminalis superior and A. terminalis inferior, the A. polaris superior arising from the trunk of the splenic or as a branch of the A. terminalis superior. The termination of the splenic artery usually occurs at the border of the middle and lower thirds of the spleen. The splenic artery breaks up into its terminal branches at a distance varying from one to seven cm. from the spleen. In 10 per cent. of the cases studied, the division of the splenic artery into its terminal branches is from 6 to 7 cm. from the spleen.

In 4 of the cases studied, the splenic artery in addition to its numerous pancreatic rami gives off at its origin an unusually large branch which is distributed to the head of the pancreas.

*A. Gastro-epiploica Sinistra.*—Its point of origin from the splenic artery is variable. The most frequent origin of this vessel is as a branch of the cephalic terminal trunk of the splenic artery. It occurs 12 times as a branch of the caudal terminal trunk. In 14 of the cases classified, this vessel arises from the trunk of the splenic artery before it breaks up into its terminal branches. In 6 of the subjects studied, it arises from the middle of the trunk, and in one instance within two cm. of the cœliac axis artery. In 5 of the subjects observed, the splenic artery gives origin to a large branch which courses cephalically and is distributed to the left lobe of the liver. The middle cœlic artery in two of the cases studied occurs as a branch of the splenic.

*A. Hepatica.*—This vessel is the most variable of three branches of the cœliac axis, and in the adult is intermediate in size between the splenic and gastric. It occurs as a branch of the cœliac axis artery in all but three of the subjects studied. In the latter it arises as a separate branch directly from the abdominal aorta. In 15 per cent. of the cases classified, it takes origin in a common trunk with the splenic artery. It arises 6 times in a trunk common with the gastric artery. In one case observed, it is found present in a common trunk with the gastric and the superior mesenteric arteries.

The hepatic artery is represented as a double vessel in 11 per cent. of the cases studied, *i.e.*, its two terminal rami—ramus dexter and ramus sinister—arise as separate branches directly from the cœliac axis artery. The hepatic artery arises as a single vessel in 89 per cent. of the cases observed and it presents great variation at the point of division into its two terminal branches. This division occurs six times within one and a half cm. from its origin and the branches pass from left to right along the free border of the lesser

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omentum as two parallel stems. In 22 per cent. of the cases studied, this division occurs at the site of origin of the gastroduodenal artery. The most frequent point of division is within two to three cm. of the portal (transverse) fissure of the liver. In 9 of the cases classified, both of the terminal branches again divide into two or more stems at or close to their origin as they ascend to gain the liver. The right hepatic artery usually passes dorsad of the hepatic duct. In a small number of subjects, it is found ventral to the hepatic duct.

*A. Gastrica Dextra (Pyloric).*—This vessel in every case observed is smaller than the left gastric artery. The most frequent origin of the pyloric artery is as a branch of the hepatic lateral to the origin of the gastroduodenal artery. In 22 per cent. of the cases studied, it occurs as a branch of the gastroduodenal artery. It is found four times as a branch of the right hepatic artery and three times as a branch of the left hepatic. The pyloric artery arises in two of the cases classified, as a separate branch directly from the cœliac axis artery. In one case observed, it is present as a branch of the superior mesenteric artery. In 21 per cent. of the subjects classified, this artery is represented as two parallel vessels which arise from the trunk of the hepatic and continue between the two layers of the lesser omentum along the lesser curvature of the stomach as two vascular arches.

*A. Gastroduodenalis.*—This artery presents few variations in its origin. Its most frequent origin is as a branch of the hepatic artery, before the latter divides into its terminal branches. In every case observed its origin is medial to the origin of the pyloric artery. In three of the cases classified, it occurs as a branch directly from the cœliac axis.

In almost every subject observed, the right gastro-epiploic artery is of greater length and calibre than the superior pancreaticoduodenal artery. The superior pancreaticoduodenal artery occurs in all but three of the subjects studied as a branch of the gastroduodenal. In the latter three subjects it is present as a branch of the hepatic artery. The right gastro-epiploic artery is found in all but four of the cases classified as a branch of the gastroduodenal, where it occurs as a branch of the hepatic artery.

*A. Cystica.*—The cystic artery shows considerable variation in size, origin and relation. Its size is usually proportionate to the size of the gall-bladder. This vessel occurs most frequently as a branch of the right hepatic artery. In those cases observed in which the right hepatic artery breaks up into two or more stems in its course to the portal fissure, the most lateral twig gains the gall-bladder and becomes the cystic artery. The right hepatic artery in 40 per cent. of the cases studied closely adheres to the dorsal surface of the cystic and hepatic ducts near their point of union, at which site the cystic artery frequently arises. In 8 per cent. of the subjects this vessel occurs as a branch of the hepatic artery before it breaks up into its two terminal branches, and as it ascends laterally towards the gall-bladder, it passes ventrad of the hepatic duct and ventrocephalad of the cystic duct to gain its usual site and distribution. In one subject the right hepatic artery is distributed entirely as the cystic. In 11 per cent. of the cases classified, the cystic artery occurs as a branch of the left hepatic. The cystic artery is usually cephalad and ventrad of the cystic duct. In 3 of the cases observed, this vessel is caudal to the cystic duct; and in 2 of the subjects it has a position lateral to the cystic duct. The cystic artery in 3 of the cases studied is present as a separate branch directly from the superior mesenteric (Fig. 5D). It is found three

times as a branch of the gastroduodenal artery. In 8 per cent. of the cases classified, the cystic artery is represented by two parallel vessels which arise separately from the right hepatic, except in 2 of these subjects in which they arise from a hepatic branch of the superior mesenteric (Fig. 5 C) and pass ventrad and cephalad to the cystic duct in their course to the gall-bladder. This additional cystic artery arises in two subjects observed, directly from the aorta

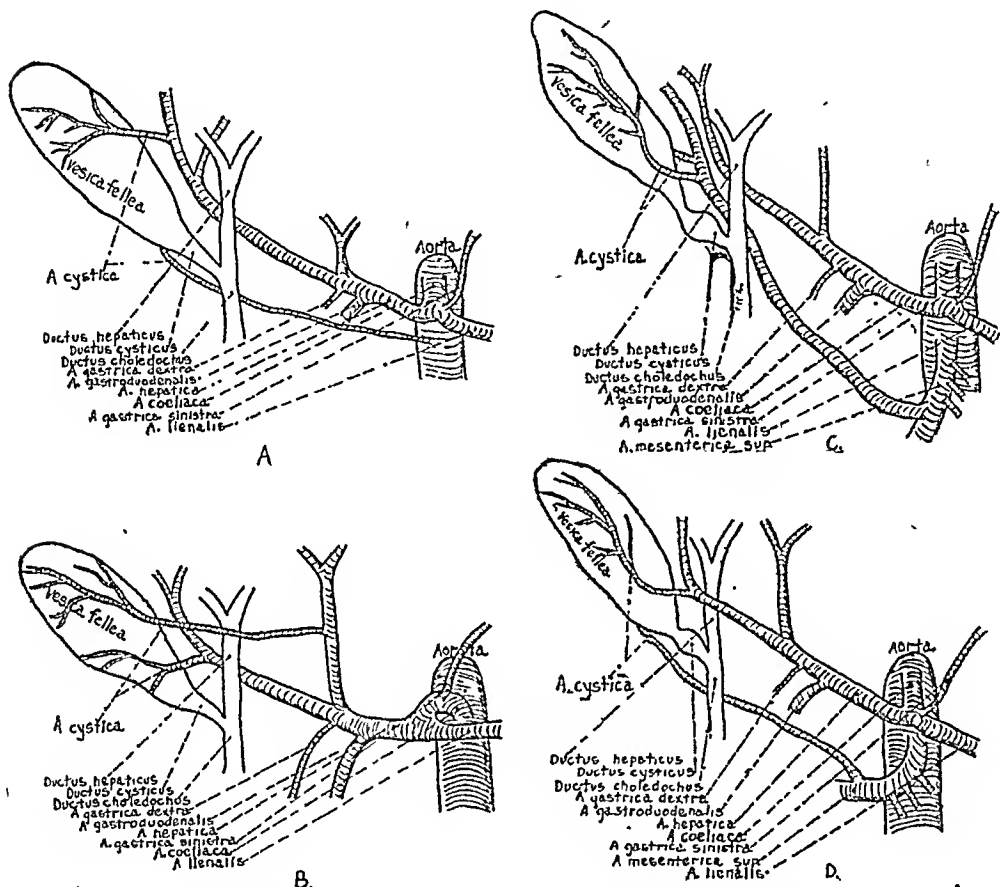


FIG. 5.—These drawings illustrate unusual variations in the occurrence of the cystic artery as a twin vessel. A, the additional cystic artery arises directly from the abdominal aorta and is found in three of the eighty-three subjects studied. B, the additional cystic artery occurs as a branch of the left hepatic and courses ventrad of the hepatic duct and right hepatic artery. This occurs in only one subject. C, both cystic arteries arise as branches of a hepatic branch of the superior mesenteric artery. This is found in two of the subjects studied. D, the additional cystic artery is present as a branch directly from the superior mesenteric artery. This variation occurs in three of the subjects studied.

(Fig. 5 A) and courses dorsad to the common bile-duct and is caudal to the cystic duct as it reaches the gall-bladder.

Rossi e Cavi in a study of 96 subjects found the cystic artery present as a twin vessel in 11.5 per cent. of the subjects; Belou in a study of 150 subjects in 19 per cent., and Branco in a study of 50 subjects, in 12 per cent.

**A. Accessoria Hepatica.**—Mention is made in the description of the gastric and splenic arteries of the occurrence of the accessory hepatic artery. In 35 per cent. of the cases classified, it occurs as a branch of the left gastric artery and in 5 subjects as a branch of the splenic artery.

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This vessel occurs in 15 per cent. of the cases as a branch of the superior mesenteric artery. It arises in a trunk common with the superior mesenteric or as a branch of the superior mesenteric from 1 to 3 cm. of its origin. The usual distribution of this vessel is as the right hepatic artery; in only two of the subjects is the anatomic distribution of this vessel as a left hepatic. The accessory hepatic artery ascends in its course to gain the liver, passes behind the stomach and pancreas, dorsal and medial to the common bile-duct, directly dorsal to the site of the union of the cystic and hepatic ducts, and at the portal fissure it is lateral to the hepatic duct and portal vein. In 4 of these subjects the gastroduodenal artery occurs as a branch of this vessel and in 3 of the subjects it gives origin to the pyloric and gastroduodenal arteries. This accessory hepatic vessel breaks up into two or more stems, one of which becomes the cystic artery or gives origin to the latter. In 3 of these cases the hepatic artery arises in its entirety from the superior mesenteric and pursues a course as outlined above.

*A. Phrenica Inferior.*—Both phrenic arteries arise 5 times as separate branches from the cœliac axis artery. In 2 of the cases studied, they arise from the cœliac axis artery in a common stem. The left inferior phrenic artery occurs 6 times as a branch directly from the cœliac axis, in 2 of which subjects this vessel gives off a number of small pancreatic rami. The right inferior phrenic artery is present in three of the cases classified as a branch of the cœliac axis.

### SECTION C—SUMMARY AND DISCUSSION

(1) A comparison of the types of the arteria cœliaca demonstrates the unusual predominance of Type I. This arrangement is present in seventy-five per cent. of the subjects and is the type described in all standard anatomical text-books. Type II occurs in fifteen per cent. of the cases and Types III and IV in ten per cent. The occurrence of Type I in so large a number of the cases classified stands out as one of the most interesting results of this study.

(2) This study embraces the dissection of eighty-three cadavers, sixty-seven male white, eight female white, six male negro, and two female negro. No relation of the branches to age could be drawn as there were only adults in this series. In the study of the femoral artery the negro subjects presented a greater proportionate number of variations and anomalies than the whites. The number of negro subjects in this series is, however, too small to present an analogous study.

(3) The left gastric artery occurs more frequently as a branch of the abdominal aorta than the splenic or hepatic arteries. The left gastric artery in thirty-five per cent. of the subjects studied is represented along the lesser curvature of the stomach as two parallel vessels. The right gastric artery (pyloric) appears as two parallel vessels in 21 per cent. of the cases studied.

The splenic artery frequently presents numerous tortuosities and is of unusually large calibre. In 30 per cent. of the cases classified, this vessel pursues a straight or only slightly tortuous course. The hepatic artery occurs as a double vessel in 11 per cent. of the cases studied. Each branch has a separate origin from the cœliac axis. The cystic artery usually arises from the right hepatic and in 8 per cent. of the subjects it appears as a twin vessel. It is usually ventrocephalad of the cystic duct.

(4) An accessory hepatic artery occurs in 35 per cent. of the cases classified as a branch of the left gastric; in 15 per cent. of the subjects as a branch of the superior mesenteric, and 5 times as a branch of the splenic. In one subject the hepatic, superior mesenteric and left gastric artery arise from the abdominal aorta in a common trunk. The hepatic artery arises three times in its entirety from the superior mesenteric. In 25 per cent. of the cases studied, the cœliac axis gives off only two branches—in 15 per cent. it is the hepatic and splenic arteries, in 6 per cent. the hepatic and the gastric, and in 4 per cent. the splenic and the gastric. Rossi e Cavi in a study of 102 subjects found the cœliac axis artery absent in 2 of the subjects; its branches, the gastric, splenic and hepatic arteries arising independently from the abdominal aorta.

(5) An unusually interesting anomaly occurs in two of the cases observed, the so-called "truncus cœliaco-mesenterica" (Ratke and Meckel). The cœliac axis and the superior mesenteric arteries take origin in a common trunk. This is an entirely normal condition in the anuria, some of the chelonia, and some of the mammalia (Keibel and Mall). Tandler interprets this as a result of the persistence of the large primitive ventral anastomosis between the early segmental cœliac axis and superior mesenteric groups. This longitudinal anastomosis is the trunk of origin for the gastric, splenic and hepatic arteries. The main part of the trunk is the superior mesenteric and as this is the stronger vessel it in this way takes over the branches which usually arise from the cœliac axis. The presence of a partial persistence of this longitudinal anastomosis explains the occurrence of the origin of the hepatic artery or an accessory hepatic artery from the superior mesenteric.

(6) The contention of Ruge in 1883 that arterial variations group themselves into distinct anatomic types is supported by the studies of Hitzrot, Bean and those of the writer. The descriptions of the arterial trunks as contained in standard anatomical text-books conform usually to but one type. Composite studies of the individual arterial trunks,

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each study embracing the investigation of a large number of cadavers, disclose that the variations found allow of a natural grouping into distinct anatomic types.

The usual and accepted conventional opinion, that whenever a vessel occurs which is at variance with the classic text-book description it is an anomaly, needs to be revised. In studying a large number of arteries of one of the large arterial trunks of the body, certain variations are found to occur with sufficient frequency to justify the establishment of distinct groups. At times variations occur which differ so widely from the normal types of the vessel that they cannot be classified; these alone should be termed anomalous.

This interesting phase of anatomical study—the establishment of anatomic types, simplifies and makes more easy of comprehension all the variations of the large arterial trunks of the body. A knowledge of the types of the larger arterial trunks will aid the surgeon in avoiding troublesome and dangerous hemorrhage that otherwise could not be averted, and it is incumbent that he move slowly in operative procedures until he has determined the exact anatomy of the part. The constant variations in size, calibre and number of the branches may be an etiological factor in the production of certain pathologic conditions.

Professor J. Parsons Schaeffer, head of the Department of Anatomy of the Jefferson Medical College, at whose suggestion these studies were begun, kindly permitted me to make full use of all the material in his department and I take this opportunity of expressing my thanks for his interest, attention and criticism in this work.

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# A COMPARISON OF THE PERMANENCE OF FREE TRANSPLANTS OF BONE AND CARTILAGE

AN EXPERIMENTAL STUDY

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(From the Hunterian Laboratory of Experimental Surgery)

*Introduction.*—The appearance in the last year or two of a number of clinical papers still strongly advocating the transplantation of bits of tibia or sections of bony ribs for the relief of saddle nose, has interested me considerably. From the results of my experimental work on cartilage transplantation, and also on bone transplantation, I had concluded that cartilage was by far the best material to use in such cases.<sup>1</sup> My clinical experience with transplanted cartilage had also been so satisfactory in the treatment of saddle nose and in rhino-plastic operations, that I had entirely discontinued the use of any other substance. However, as there seemed some difference of opinion as to the relative stability of bone and cartilage transplants, I carried out the following procedures in order to clear up the matter, at least from an experimental standpoint.<sup>2</sup>

The experiments were carried out on dogs, and the ordinary run of laboratory animals was used. Ether anæsthesia was used in each experiment.

*Technic.*—The part was shaved, washed with green soap and water, followed by alcohol and then with ether. Fine black silk was the ligature and suture material used throughout. The healing was *per primam* in each experiment reported.

In order to produce conditions which would be somewhat similar to those in actual clinical practice, I transplanted the cartilage and bone so that one extremity of the transplant was in close contact with a denuded portion of a membranous bone, while the remaining portion of the transplant extended into the soft parts.

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<sup>1</sup> Davis, J. S.: The Transplantation of Rib Cartilage into Pedunculated Skin Flaps. An Experimental Study. J. H. H. Bull., vol. xxiv, April, 1913, p. 116; also Davis, J. S., and Hunnicutt, J. A.: The Osteogenic Power of Periosteum; with a Note on Bone Transplantation. An Experimental Study. J. H. H. Bull., vol. xxvi, March, 1915, p. 69.

<sup>2</sup> I take this opportunity of thanking Dr. LeR. N. Fleming for his aid in the operative experiments.

## · FREE TRANSPLANTS OF BONE AND CARTILAGE

The cartilage was obtained from the cartilaginous ribs, which is the usual clinical source of supply. The spongy bone was obtained from the ribs, and the hard bone from the fibula. Auto transplants only were used.

*Experiments.*—The experiments were grouped as follows: (1) Cartilaginous rib with perichondrium, and bony rib without periosteum. (2) Cartilaginous rib with one-half perichondrium, and bony rib without periosteum. (3) Cartilaginous rib without perichondrium, and bony rib without periosteum. (4) Cartilaginous rib without perichondrium, and bony rib with one-half periosteum. (5) Fibula with its periosteum, and fibula denuded of its periosteum.

*Typical Experiment.*—Series D1. Mongrel dog, about two years old.

*Operation.*—A section of bony rib was removed subperiosteally from the right side, and also a section of cartilaginous rib with its perichondrium. Through a short incision in the temporal muscle, the periosteum of the parietal bone was button-holed, and a small pocket was burrowed beneath it. Into this pocket the bevelled end of the transplant was placed, so that the graft came in close contact with the denuded bone. The rest of the transplant was buried in the temporal muscle, which held it firmly in place. Both transplants were 2 cm. long. In each experiment the bony rib was placed on the right side and the cartilage on the left side of the skull.

*Group 1. The Transplantation of Cartilage with Its Perichondrium Intact, and Rib Without Periosteum. Summary.*—Six experiments were done. The specimens were examined 24, 25, 85, 223, 576 and 582 days after operation. In each instance the cartilage was found apparently intact, and 2 cm. in length. After 24 and 25 days there was little change in the length of the bone, although beginning absorption was noted. In the 85 day specimen there was rather a dense outgrowth of bone from the skull about the impinging portion of the transplant. This gave the impression of being rather excessive, when compared with the other specimens, and might have been caused by a slight localized infection. There was also marked evidence of absorption, although the bone was still 2 cm. in length. After 223 days no bone whatever could be found, either by X-ray or by careful dissection. In the 576-day specimen a very small spicule of bone was found projecting from the skull, this bone was pitted and was very irregular in shape. It may have been new bone from the skull, rather than the remains of the transplant. Its greatest measurements were 2 mm. in length and breadth and 1 mm. in thickness. In the 582 day specimen a tiny irregular spicule of bone, not more than .5 mm. long, projected from the parietal bone.

This group seems to show that under exactly the same conditions transplanted cartilage and spongy rib bone behave quite differently. The cartilage retains its original size, while the bone, on the other hand, in the shortest experiment shows a tendency to absorption, and this progresses as time goes on. It is difficult to say why the bone in the 223-day experiment should have entirely absorbed, while evidences



remained of the transplant in other experiments observed for more than twice that length of time.

*Group 2. Cartilage with One-half of Its Perichondrium (Lengthwise) and Rib Without Periosteum. Summary.*—Four experiments were done. The specimens were examined 44, 125, 374, and 505 days after operation. In each instance the cartilage was found to be the same length as when transplanted. After 44 days the bone was a scant 2 cm. long and showed evidences of absorption. After 125 days the bone was 1 cm. long, very thin and nearly absorbed. After 374 days only a thin spicule of bone, 8 by 2 mm., remained. After 505 days a very thin fragment, 7 by 2 mm., remained.

*Group 3. Cartilage without Perichondrium, and Rib Without Periosteum. Summary.*—Two experiments were done. The specimens were examined 165 and 332 days after operation. In both experiments the cartilage was found to be 2 cm. long and apparently intact. In the 165 day specimen the bone had entirely disappeared. After 332 days the bone was 7 by 1 mm., being thin and flexible.

These groups again emphasize the tendency of bone to be absorbed, and of cartilage to retain its original length and thickness, even though partially or wholly denuded of its perichondrium. It is impossible to say why one of the rib transplants had disappeared in 165 days, while thin fragments of bone, showing all the signs of degeneration, were found 332, 374 and 505 days after transplantation.

*Group 4. Cartilage without Perichondrium and Rib with Strip of Periosteum. Summary.*—Four experiments were done. The specimens were examined 13, 26, 49, and 56 days after operation. The cartilage remained unchanged in each experiment. In the 13 day experiment there was no change in the size of the bone. In the 26 and 56 day experiments the bone, which was 2 cm. long when transplanted, was found to be 1.6 cm. long, and in the 48 day experiment it was 1.4 cm. long.

This again shows the tendency of bone to absorb, in spite of the presence of a strip of undisturbed periosteum, and the cartilage to be unchanged, even though the perichondrium is removed.

*Group 5. A Section of Fibula, with Periosteum, and a Similar Section Without Periosteum, were Transplanted as in Previous Experiments. Summary.*—Three experiments were done. The sections of fibula to be compared were of equal length, and varied between 1.4 and 1.8 cm. in the different experiments. The specimens were examined 305, 328 and 388 days after operation. In each experiment the section of fibula without periosteum had been absorbed. In the 305 day experiment the section of fibula with periosteum, which was originally 1.8 cm. long, measured 5 mm. long by 1 mm. at its widest, and was thin, irregular and flexible. In the 328-day experiment the transplant, which was covered with periosteum and which was originally 1.75 cm. long, measured 8 mm. in length by 1 mm. in width, and was thin and flexible. After 388 days the section of fibula covered with periosteum, which was originally 1.4 cm. long, measured 7 mm. in length by 1 mm. in width, and was thin and flexible.

FIG. 1A.

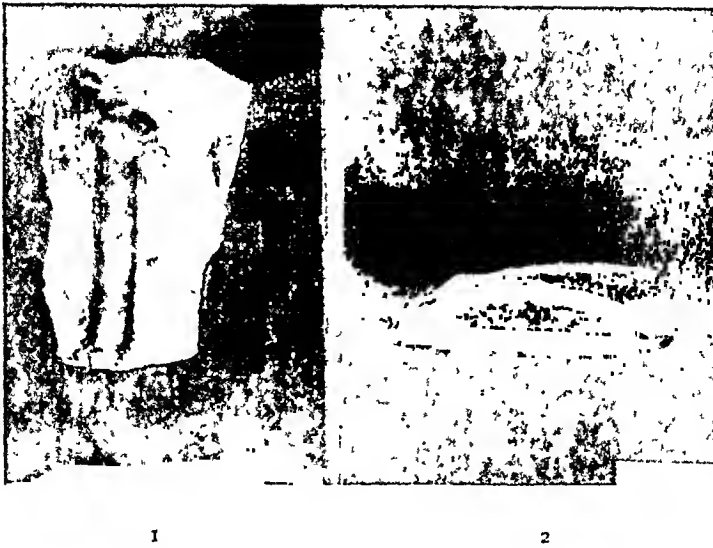


FIG. 1B.



FIG. 1.—Experiment D4. Cartilage with perichondrium, rib without periosteum, each 2 cm. long when transplanted. Eighty-five days after transplantation. *A*, cartilage, still 2 cm. long. 1, from above; 2, profile view. *B*, bone, scant 2 cm. long. 1, from above; 2, profile view; 3, profile view, X-ray; 4, control rib, 2 cm. long. *B*, 1, shows excessive bone formation around impinging portion of transplant. Note absorption of bone on free extremity shown in *B*, 3, when compared to control.



FIG. 2.—Experiment D3. Cartilage with perichondrium, 2 cm. long, when transplanted. Two hundred twenty-three days after transplantation. The cartilage is still 2 cm. long. The rib transplant without periosteum in this experiment had been absorbed.

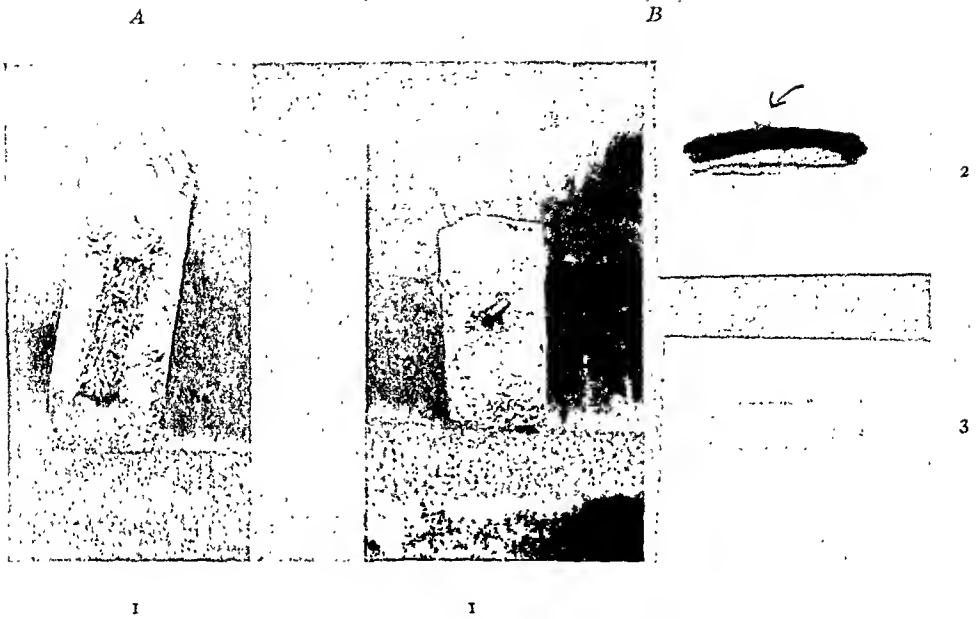


FIG. 3.—Experiment D1. Cartilage with perichondrium, rib without periosteum, each 2 cm. long when transplanted. Five hundred seventy-six days after transplantation. A, cartilage, still 2 cm. long. I, from above. The specimen had dried out before this photograph was taken. B, bone, small nubbin, 2 mm. long. 1, from above; 2, profile view, X-ray; 3, control rib, 2 cm. long. Note comparative size of remaining bone with control.

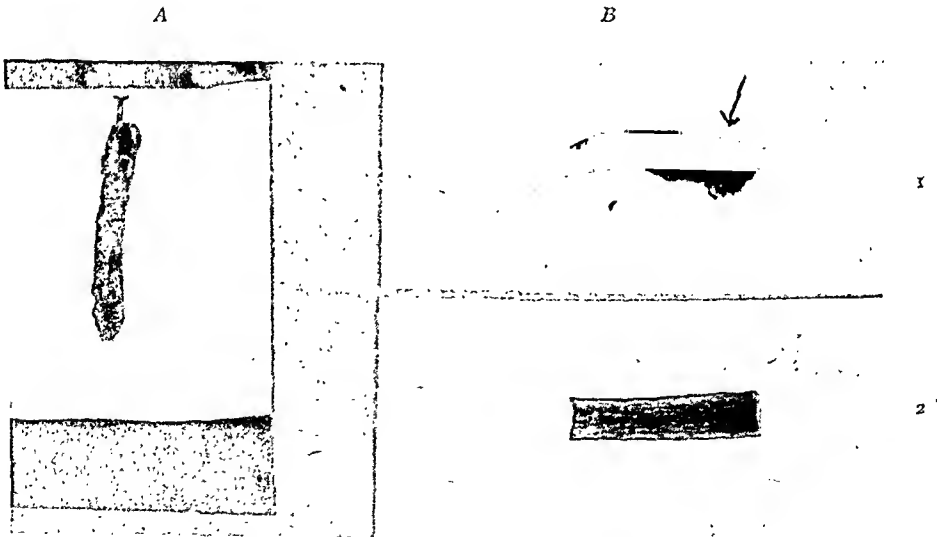


FIG. 4.—Experiment D5. Cartilage with perichondrium, rib without periosteum, each 2 cm. long when transplanted. Five hundred eighty-two days after transplantation. A, cartilage, still 2 cm. long. B, bone, small nubbin, .5 mm. long on parietal bone. 1, profile view, X-ray; 2, control rib, 2 cm. long. Note amount of absorption when compared with the control.

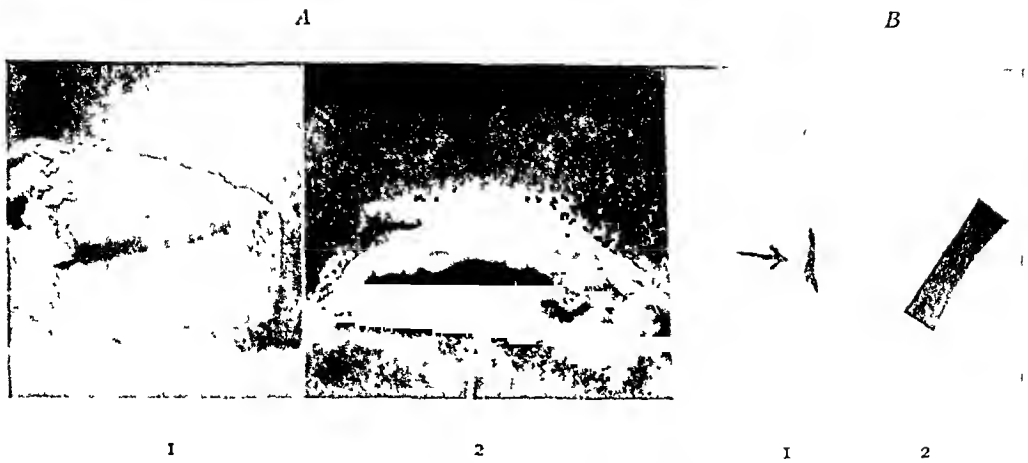


FIG. 5.—Experiment D9. Cartilage with one-half perichondrium, rib without periosteum, each 2 cm. long when transplanted. One hundred twenty-five days after transplantation. *A*, cartilage, still 2 cm. long. 1, from above; 2, profile view. *B*, bone 1 cm. long, thin and irregular. 1, X-ray of transplant; 2, X-ray of control bone, 2 cm. long. Note good condition of cartilage and great amount of absorption of bone when compared with the control.

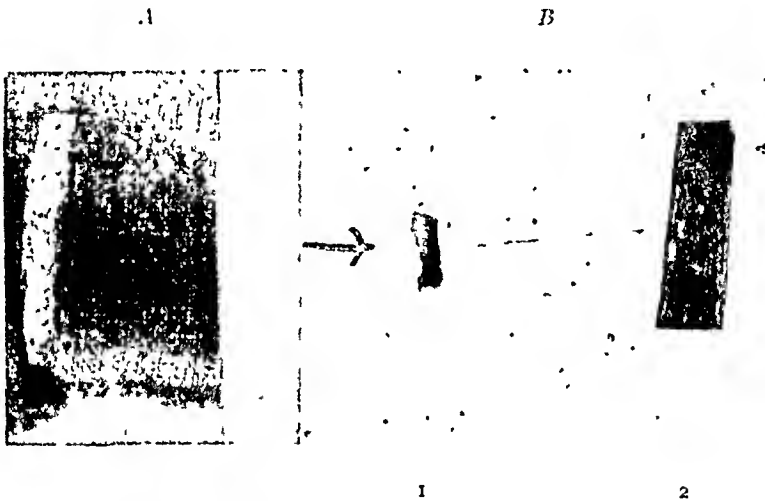


FIG. 6.—Experiment D13. Cartilage with one-half perichondrium, rib without periosteum, each 2 cm. long when transplanted. Three hundred seventy-four days after transplantation. *A*, cartilage, still 2 cm. long. *B*, bone 8 mm. long, thin and irregular. 1, X-ray of transplant; 2, X-ray of control, 2 cm. long. Note absorption of bone.

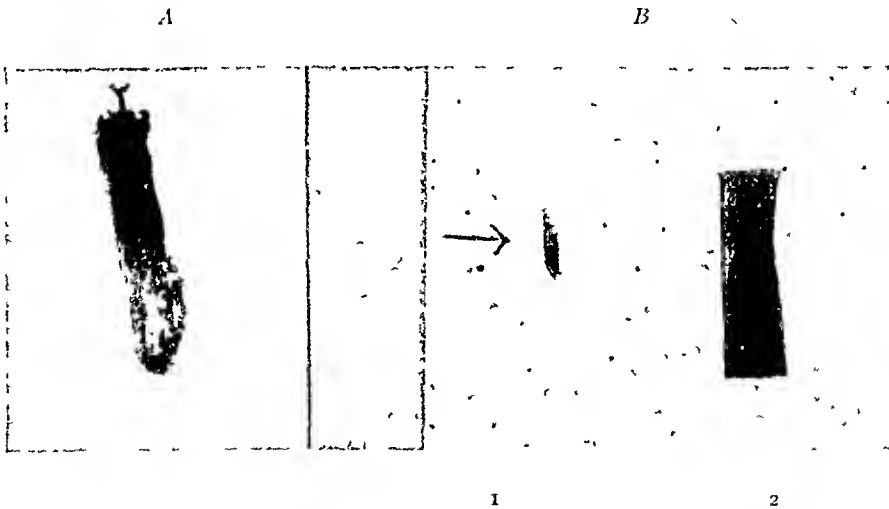


FIG. 7.—Experiment D8. Cartilage with one-half perichondrium, rib without periosteum, each 2 cm. long when transplanted. Five hundred five days after transplantation. *A*, cartilage, still 2 cm. long, and in good condition. *B*, bone 7 mm. long, thin and irregular. 1, X-ray of transplant; 2, X-ray of control, 2 cm. long. Note bone absorption.

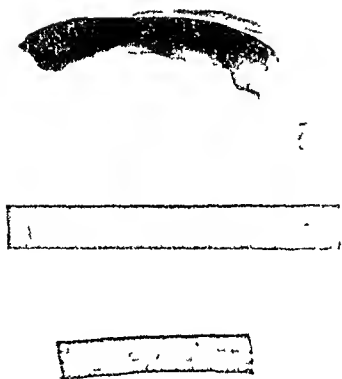


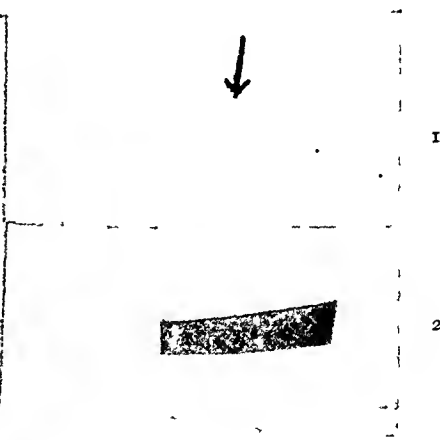
FIG. 8.—Experiment D12. Cartilage without perichondrium, rib with strip of periosteum, each 2 cm. long when transplanted. Fifty-six days after transplantation. Bone, 1.6 cm. long. 1, X-ray of transplant; 2, X-ray of control 2 cm. long. Note absorption. The cartilage in this experiment was unchanged.



FIG. 9.—Experiment D16. Cartilage without perichondrium, rib with strip of periosteum, each 2 cm. long when transplanted. One hundred sixty-five days after transplantation. Cartilage still 2 cm. long, although not in contact with the skull. The bone in this experiment had been absorbed.



A



B

FIG. 10.—Experiment D17. Cartilage without perichondrium, rib with strip of periosteum, each 2 cm. long when transplanted. Three hundred thirty-two days after transplantation. A, cartilage, still 2 cm. long. B, bone, very thin, 7 mm. long. 1, X-ray of transplant; 2, X-ray of control, 2 cm. long. Note absorption of bone.





## FREE TRANSPLANTS OF BONE AND CARTILAGE

The group shows that the hard bone of the fibula is absorbed, as well as the more spongy bone of the rib. It also confirms experiments previously reported, which showed that a bone covered with periosteum is more resistant to absorption than denuded bone, but that in time it also will be absorbed.

*Remarks.*—It has been often demonstrated that free bone, either with or without periosteum, when transplanted into soft parts, without any particular function, will eventually be absorbed. From these experiments this also seems to apply to free bone transplants with one end in contact with denuded bone, as in no instance, where any considerable time elapsed, did the transplant seem to hold its own against absorptive processes. In the experiment of longest duration only a tiny spicule of bone remained projecting from the parietal bone, and it is obvious that this remaining spicule of bone would have been insufficient had the original transplant been used as a supporting framework.

I found in a previous series of experiments that when a pedunculated flap of periosteum, with a thin layer of bone, was raised and the soft parts were sutured beneath, there was at first a marked thickening with production of new bone, but that in time this thickened portion was absorbed, and the length of the bone-periosteal flap much reduced. If this is the fate of a flap which is pedunculated, it is much more likely that absorption will take place in a free bone graft, which may, or may not, impinge firmly against denuded bone at one end.

My experience with bone transplantation leads me to believe that if new bone should be formed, it would never be long enough or strong enough to give proper support to the part.

The cartilage in each experiment showed no signs of absorption, and was normal in appearance, even when entirely denuded of perichondrium. In no instance was there any increase in the length of the cartilage.

The free end of the cartilage had become rounded in all the experiments. The end of the cartilage in contact with the skull was firmly adherent to it in some experiments, while in others it was slightly movable.

The healing was reactionless, and the cartilage did not act as a foreign body. The measurements of the cartilage differed very little, if at all, from those taken at the time of transplantation. On section, the cartilage appeared normal and seemed well nourished.

In several experiments the transplants became dislodged from con-



tact with the skull, and were found in the adjacent soft parts, but in every instance the cartilage was unchanged, while the bone had either disappeared or showed signs of absorption, the extent of which depended on the length of time following transplantation.

Microscopic examination of the transplanted cartilage when compared with the control sections, showed remarkably little change in the condition of the cartilage. The most striking feature was the absorption of the central areas of calcification. The cells were for the most part in good condition, and showed well stained nuclei. Some of the cells of the outer layers varied in staining properties, but the whole impression was that of living cartilage. It is not possible to say whether new cells had been formed, although in some of the sections longest transplanted there seemed very active groups of cells in the central areas. The presence or absence of perichondrium seemed to have little effect on the nourishment of the cartilage cells.

Cartilage is flexible and thus is less liable to subsequent fracture; it can be easily cut and shaped into any desired form; it is no more difficult to obtain than bone, and a large supply is always available. Any one of these advantages, it seems to me, would suggest the use of cartilage rather than bone for the supporting material in transplantation for the correction of saddle nose, and also for the framework in rhinoplastic operations.

*Conclusion.*—These experiments show that transplants of free cartilage are unchanged during the length of time under observation, while free bone transplants under exactly the same conditions had either disappeared or showed marked degenerative processes.

# STUDIES ON PAGET'S DISEASE OF THE NIPPLE AND ITS EXTRAMAMMARY OCCURRENCE\*

REPORTS OF EIGHTEEN CASES PERSONALLY INVESTIGATED

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PAGET'S disease of the nipple is of interest to clinicians and pathologists because it is still to be decided whether it is cancer or a precancerous condition. Although many, especially clinicians, at present are inclined to believe it precancerous, the basis for their deduction is not yet sufficiently decisive. Moreover, some authors believe that the term is used to designate various different affections. Napier described a long-continued eczematous condition which healed without cancerous formation. He believed that at least two conditions have been included under the term "Paget's disease"—the one, a true cancerous condition, the other a simple chronic eczema. According to Besnier, there are several forms of Paget's disease: in the first, there is induration and retraction of the nipple, and operation should be undertaken at once; in the second, there is no induration or retraction of the nipple, and immediate intervention is not necessary. Czerny expressed his opinion in Hanser's dissertation: "Überhaupt ist dieser Name eine ganz vage Bezeichnung geworden: denn es besteht eine grosse Differenz zwischen einzelnen Berichten und auch in dem (den meisten Beziehungen), einheitlichen Krankheitsbilde von Paget selbst, dass man ja schliesslich ebensogut jede Erkrankung der Warzen wie des Warzenhofes so benennen könnte—einerlei welcher Natur sie ist, einerlei ob ihr ein Drüsenkrebs der Mamma folgt oder nicht." Depage observed one glandular cancer of the breast which made its way through the milk-ducts into the epidermis and caused an eczematous condition, but with no coccidia-like bodies in the sections. This case he called "pseudo-Paget disease." Malinowski reported a case of colloid cancer of the breast followed by an eczematous alteration of the skin due to retrograde metastasis. Jopson and Speese noticed an early case of diffuse, scirrhous carcinoma associated with a dry and limited eczema of the nipple which they concluded should be distinguished from true precancerous Paget's disease.

In this article I shall discuss only cases of genuine Paget's disease

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\* This material was obtained and studied partly in Prof. T. Kondoh's Clinic (the Imperial University of Tokyo) and partly in Dr. W. C. MacCarty's pathological laboratory (Mayo Clinic, Rochester, Minn.).

not preceded by tumor in the deep layers. The details of each case will be given.

*Nomenclature.*—Paget's disease has been variously designated according to various opinions in regard to its nature. Besnier described it as "Epitheliomatosé eczématoïde de la mamelle." Thin called it "Malignant papillary dermatitis." Lang called it "Dermatosis epithelialis (degenerativa) circumscripta eczematiformis," Terzaghi and Campana, "Eczema psoriasiformis," and Piffard, "Mammalitis maligna." Hirschel suggested the name of "Krebs-eczema der Brust." The term "Paget's disease of the nipple" now generally used to describe the condition was given by Erichsen in 1879.

*Cases Recorded.*—Jacobaeus (1904) found 70 or 80 cases of this disease reported in the literature; Hannemüller and Landois (1908) collected about 100 case reports; Rosenberg (1909) nearly 120; Reuter (1912) about 130. In my study of the literature, I found more than 200 case reports, 196 of which I read in the original reports or abstracts.

*Symptomatology.*—The earliest symptom appears usually on the surface of the nipple, rarely on the areola or skin, as a pimple, a pustule, a crack, a red patch, a scab, a horny crust, or an excoriation. Paget distinguished two general types: one, weeping eczematous, the other, dry psoriatic. These may be mixed, or one type may change into the other during the morbid process. Gradually such skin changes spread over the entire nipple and extend over the areola. Rarely do they spread beyond the region of the latter, though in Von Winiwarter's case the condition affected not only the breast but the right thorax and the axilla up to the arm. Vignolo-Lutati, Elliot, Sherwell, and others, reported cases in which the patch extended far beyond the areola. In many cases subjective symptoms are absent. At times in the beginning there is itching; as a rule, this disappears subsequently, though it may be continuous. Often a burning and tingling sensation is complained of; rarely is there shooting or darting pain. When the affection is fully developed, the skin is a very bright red, its surface looking as if lacquered, smooth, eroded, in places superficially ulcerated, and showing sometimes fine granulations. White epithelial islets are often disseminated on the surface. In other places, excoriation or scab formation prevails. The ground of these patches in many cases is not infiltrated. Sometimes, however, peculiar superficial parchment may be palpated ("*Induration papyracé ou en carte de visite*"—Darier). The borders are always well defined and polycyclic, sometimes distinctly indurated. According to some authors, this is the only diagnostic sign by which it may be differentiated from ordinary eczema. Often a little clear viscid fluid is dis-

charged from the ulcerated surface, or a bloody secretion from the nipple is noticed early in the disease. Many authors since Brocq have concluded that Paget's disease attacks the right nipple more often than the left. In my search of the records, however, I found the contrary to be true. Among 114 cases in which the side affected was stated, the left breast was involved in 60 cases, and the right in 48. In 6 cases the disease occurred on both sides (Lewis, 2 cases, and Tschlenoff, Abrahams, Rosenberg, Jones, each 1 case). The length of stated time that elapsed before the tumor was seen clinically is variable. The shortest time recorded was several weeks (Butlin) and several months (Bowlby); the longest, 20 years (Jamieson), 23 years (Savatard), 25 years (Sekiguchi), 30 years (Fabry and Trautmann). The average interval is one, two, or three years. On the other hand, there are many cases in which no definite tumor mass can be detected clinically even after a long period of time, although sections reveal cancer in the tissue distinctly. In only a few cases was a hereditary tendency towards cancerous disease reported. Of 159 patients, 49 had nursed children. A previous inflammatory process in the breast was recorded by Bowlby, O'Neill, Oldekop, Schulten, Tschlenoff, Andry, Elder, Rolleston and Jopson and Speese. Hanser's case was suddenly exacerbated by erysipelas after the advent of the disease. Trauma seems to have little relation as an etiologic factor in this affection. In Kyrle's case the patient reported that she had had a blow and bruise one and a half years previously. In Murphy's and Sekiguchi's cases injury had occurred 2 years before the appearance of the first sign on the skin, and in Jacobæus's case 7 years before. Hartzell reported a case of a pigmented mole on the forearm which, after being bruised a number of times and undergoing inflammation, caused the association of a nævocarcinoma with the condition of Paget's disease. Cases of this affection on the male breast were reported by Forrest, Jones and Elbogen. I have examined one in addition, making a total of 4 cases.

*Extramammary Paget's Disease.*—The following regions have been reported as areas in which affections resembling mammary Paget's disease occur: (1) External reproductive organs of male: (a) Scrotum and penis, 4 cases (Crocker, 2 cases; Darier and Couillaud; Rolleston and Hunt); (b) glans penis, 5 cases (Pick, Tommasoli, Tarnowsky, Sequeira, Davis); (c) præputium and frænulum, 1 case (Pospeloff). (2) External reproductive organs of female; vulva, vagina and perineum, 4 cases (Dubreuilh, Rosenberg, Grintschar, Kren). (3) Axilla, 3 cases (Zieler, Holzknecht, Jungmann and Pollitzer). (4) Umbilicus, 2 cases (Fox and MacLeod, Milligan). (5) Nose, 2 cases (Ravogli,

Matzenauer). (6) Buttocks, 2 cases (Fordyce). (7) Neck, 1 case (Morris). (8) Lower lip, 1 case (Winfield). (9) Abdominal wall, 1 case (Sheild). (10) Forearm, 1 case (Hartzell). (11) Back, 3 cases (Towle, Belot, Omsby).

There has been a total of 30 cases recorded as extramammary Paget's disease. To these I shall add 1 case in which the scrotum was affected.

Many different opinions have been published in regard to the nature of Paget's disease. Briefly, they may be summarized as follows: (1) Ordinary eczema; (2) irritation by a benign tumor of the breast; (3) epithelial dystrophia by neuritis and perineuritis; (4) a peculiar disease, *sui generis* precancerous: (a) psorospermosis, (b) blastomycosis, (c) degenerative epithelial dermatosis; (5) melanoblastoma; (6) nævocarcinoma; (7) primary superficial epithelioma; (8) primary glandular-cell carcinoma from the superficial milk ducts.

#### REPORT OF CASES PERSONALLY OBSERVED

CASE I (Kondoh's Clinic).—Mrs. K., aged sixty-one years. No history of cancer in family. Married at nineteen; husband healthy. Has given birth to, and nursed, ten children. Has had no inflammation in the breast.

*Clinical History.*—Six years ago, while she was working in a chemical factory, she noticed a burning sensation on the left nipple. As she had dropped hydrochloric acid on her waist several days before, she concluded that the burn had been caused by the acid. At that time there was a small spot on the nipple, the size of a grain of rice. The area was whitish and excoriated. The eczema spread gradually over the areola. Three months later the nipple flattened and almost disappeared. There was no itching or pain, only a sensation of burning.

*Clinical Examination.*—Left nipple was flattened. The surface was ulcerated and exuded a viscid fluid. The eczematous area, 9 by 6.8 cm., on the breast was bright red in color and eroded. Part of it was finely granular and a part glistening. Whitish epithelial islets were also to be seen. The margins of the patch were sharply defined, polycyclic and not elevated. There was neither induration nor a nodule in the subcutaneous and deep layer. No glandular enlargement in the axilla.

*Operation.*—On September 21, 1910, the breast was amputated and the axillary glands cleared out.

*Pathologic Findings.*—The granulation tissue in the site of the nipple contained enormous plasma cells and newly-formed blood-vessels. There was found also a long column of large proliferated epithelial cells running vertically into the deep layer, which was varied and irregular in shape. Some of the cells were very deeply stained. I believe that this column was a degenerated cancerous lacteal duct. In the remaining

## PAGET'S DISEASE OF THE NIPPLE

epidermal layer surrounding the ulcer was a number of big clear cells. These cells were scattered in the epidermal layer of the eczematous part, but were most numerous at the edge of the ulcer near the long cancerous column. In the deep layer were variously shaped rows of cancer cells of the glandular type surrounded by moderately increased stroma, and signifying carcinoma simplex. The cancerous column of the lacteal duct extended into the corium. It was not connected with the cancer rows in the mammary glands, but was separated from them by increased elastic and connective tissue. The separation of both parts might be considered secondary, the result of the reactive process in the corium. There was no glandular involvement in the axilla.

CASE II (Kondoh's Clinic).—Mrs. I., aged forty. No cancerous tendency in family. Married at seventeen; never pregnant.

*Clinical History.*—About ten months before she accidentally scratched the right nipple with her finger-nail. Since that time the skin had been excoriated and a scab had formed and fallen off again. At the end of five months, she noticed that the mammary gland of that side was somewhat enlarged. One month later a fluctuating area appeared near the nipple, which spontaneously ruptured and produced an ulcer exuding bloody serous fluid. She complained of some pain.

*Clinical Examination.*—The right breast was much enlarged. Dilatation of subcutaneous veins was visible ("Caput medusæ"). The nipple had ulcerated and disappeared. The areola surrounding the ulcer was eroded and exuded serum. Under the nipple on the outer side was another ulcer. In its centre was the opening of an exuding fistula. In the deep layer could be felt a large, hard tumor the size of the fist. The tumor was attached to the base of the ulcer and the pectoral muscle. Several hard nodules were felt in each axilla.

*Operation.*—On February 19, 1913, the breast was amputated, the pectoral muscle removed, and the axillary glands dissected out.

*Pathologic Findings.*—The nipple had been replaced by granulation tissue in which plasma, round, eosinophile and mast cells were greatly in evidence. The elastic tissue had almost disappeared, but in the borders of the ulcer it remained slightly condensed. Just below the granulating surface a large cancerous mass was to be seen. The tumor in this case was almost surrounded by dense connective tissue, but toward the deep layer were scattered small raw formations. The shape of the cancer rows in the main portion was peculiar; many of them were connected with each other, the stroma mingling in an irregular vine-like form. Cheatle distinguished two types of duct cancer—the intracystic papillomatous, and the intracystic lactiform. This case should be classified with the latter. The epidermis of the eczematous areola showed in places abrasion of the cornifying and granular layers, and here and there a mass of degenerating epithelium with feebly stained nuclei was present; no typical "grosse und helle Zellen" were found. Therefore, it might be concluded that in this case

the eczematous condition signified a nutritive disturbance due to the compression of the larger cancer mass in the corium, and that it was not caused by an invasion of cancerous cells into the epidermis. However, the clinical history proves that this case cannot be excluded from cases of Paget's disease and considered merely pseudo-Paget's disease, for in the beginning there was no clinical sign of cancer in the deep layer. I believe that the classification of genuine and pseudo-Paget's disease is not rational, for clinically the genuine form, as in this case, should be regarded as primary carcinoma which was latent in the milk duct.

**CASE III (Kondoh's Clinic).—**Mrs. O., aged sixty-four years. Family history negative. Married at twenty-five; had borne and nursed five children. No trauma or inflammation of breast.

*Clinical History.*—About one and a half years ago the patient noticed a red spot the size of a pinhead on the tip of the nipple. Four months later it eroded and there was a little exudate. At the same time a small hard nodule appeared in the nipple, which gradually retracted and disappeared. The eczema spread continuously on to the areola.

*Clinical Examination.*—On the site of the left nipple was a crater-shaped ulcer, 0.5 cm. in diameter and 0.5 cm. deep, which exuded a slightly serous bloody fluid. The surrounding areola was bright red, eroded and sensitive, and its outer zone was of a dark color. The margins of the diseased skin were sharply defined, but not raised (Fig. 1). In the centre of the deep layer was a large hard tumor-mass the size of a child's head, which was attached to the ulcer in the nipple, but movable against the pectoral muscles. In the left axillary and supraclavicular regions, many hard glandular enlargements were palpable.

*Operation.*—April 6, 1914, the breast was removed.

*Pathologic Findings.*—In the malpighian and basal-cell layers many single Paget cells were found; they were also in rows which compressed the surrounding epidermal cells. In some places the basal-cell layer had been flattened by compression of the Paget cells. The latter, however, showed no tendency to invade the corium. While there was no distinct transitional form from the surrounding epidermal cells, there was a direct connection between these cells and the glandular cancer-cells on the edge of the ulcer in the site of the nipple. In this area the granulation tissue was mixed with numerous cancer rows which had a direct relation to the tumor-mass in the deep layer. Just below the surface of the ulcer was found a large column of cancer-cells, running downward. This may be considered the residuum of the lacteal duct. The connective tissue in the corium in places had undergone a hyaline change. The increased elastic tissue in the periphery of the cancerous mass showed peculiar granular degeneration. In some of the veins were thrombi of cancer cells and in others calcareous deposits were present. The sweat glands under the diseased skin had become atrophic and their surrounding stroma showed myxomatous degeneration. Hair follicles and Montgomery's glands in

## PAGET'S DISEASE OF THE NIPPLE

some places showed proliferation of cells which were intermingled with Paget cells. The lymph-glands along the pectoral muscle contained scirrhous carcinoma (Fig. 1).

CASE IV (Kondoh's Clinic).—Mrs. S., aged fifty years. Family history negative as regards cancer. Patient had given birth to and nursed six children.

*Clinical History.*—Six years ago she noticed a pimple on the tip of the nipple, which had broken and formed a scab. Shortly afterward another pimple appeared very near the first one; this also broke and changed into an erosion. The area was slightly sensitive to the touch. One year ago the erosion spread over the entire left nipple.

*Clinical Examination.*—The left nipple was slightly flattened; its surface eroded and showing a few whitish spots. The surrounding areola was bright red (diameter 5 cm.), partly eroded, and exuding clear serum. The borders of the patch were distinctly defined and slightly raised. There was neither induration nor nodules in the superficial or deep layers.

*Operation.*—On November 11, 1914, the breast was amputated.

*Pathologic Findings.*—The cornified stratum of the diseased nipple had disappeared almost entirely; in places all of the epidermal layers were eroded and replaced by small ulcers. In the epidermis near the outlet of a milk duct, a number of Paget cells were found, especially in the malpighian and basal-cell layers. These cells were scattered also in other parts of the eczematous skin, but their number was relatively small in comparison with those in the vicinity of the milk duct. In the corium of the nipple a long column of glandular cells extending down to the deep layer was evidently a cancer-changed lacteal duct, and in serial sections it was found to be directly connected with the smaller milk ducts. The cancerous degeneration of the wall of the milk ducts was apparently gradual. The most manifest development of carcinoma took place in the superficial lacteal duct and invaded the branches in the deeper layer along its course. In some of the small milk ducts, one side of the wall had not lost its normal columnar epithelial lining, although the other side had changed into cancer and invaded the surrounding stroma (Fig. 17). Around these milk ducts elastic tissue was very much increased. In connection with this case emphasis should be laid upon the fact that only one lacteal duct in the nipple had changed into cancer, and that others found in the sections showed dilatation of the lumina, but no cancer. In the subpapillary corium the infiltration of plasma cells, eosinophile cells, mast cells and small lymphocytes was striking. The first formed an annular infiltration around cancer rows from the milk ducts. The increase of the elastic tissue in the corium of the nipple was remarkable, most of its fibres running vertically (Fig. 19). The same tissue increased also surrounding the cancerous degenerating milk ducts in the deeper layer (Fig. 18).

CASE V (Kondoh's Clinic).—Mrs. I., aged fifty-five years. Family history in regard to cancer negative. Patient had never been pregnant. Ten years ago she suffered from myoma of the



uterus which was treated with injections of ergotin, resulting in much improvement. No clinical symptoms since. Twelve years ago a tumor about the size of a nut appeared in the right breast. It was removed and proved to be benign.

*Clinical History.*—Twenty-five years ago the patient discovered a slight scab formation on the tip of the left nipple which itched slightly. It was followed soon after by erosion with exudation of serous fluid. Two years later the entire left nipple was eroded. Eight years after the beginning of the disease the eczematous condition spread over the whole areola. Itching and dull pain were complained of (Fig. 3). In July, 1913, the patient was treated by Röntgen rays once a week. After six treatments an acute dermatitis of moderate intensity developed (Fig. 4). This was healed in the course of two weeks by the application of tumenol—Wilson paste. With the disappearance of the dermatitis, the morbid condition of the skin was entirely cured with epidermatization. Depigmentation, however, still indicated the old diseased area (Fig. 5). The surrounding normal skin was over-pigmented. The nipple was flattened up to the trace. Half a year later the eczematous change of the skin again developed in the upper inner quadrant of the breast, some distance from the nipple. The latter was pinkish in color and injected. A hard tumor mass was palpated in the mammary gland just beneath the nipple. The lymph-glands in the axilla were not enlarged.

*Operation.*—On November 21, 1914, the breast was amputated.

*Pathologic Findings.*—The thickness of the epidermal layer of the nipple and areola was reduced, but unimpaired. The epidermis appeared dense; in other words, the intracellular spaces of the malpighian layer were decreased, and as a result the cells were closer together. There were no epithelial alterations and no Paget cells excepting in a small area of the areola. In the corium was a dense connective-tissue-like scar. Plasma cells and elastic tissue, which were characteristic features in the other cases, were scarce. I believe that this was due to the use of the Röntgen ray, which probably suspends cell-infiltration and elastic-tissue hyperplasia in the corium. The fact that some sweat glands were evidently atrophic and their periglandular stroma had undergone hyaline degeneration, must be ascribed to the same cause. Beneath the nipple, intercepted by the above-mentioned dense connective tissue, was a large cancerous mass which consisted of small glandular cells and very little stroma. On the inside it showed a typical alveolar formation. In the centre of the large focus some coagulation necrosis had occurred. The appearance of the small area on the areola, where the eczematous condition had recurred, was peculiar. The stratum corneum and granulosum had been destroyed, the malpighian layer was sprinkled with Paget cells, and the surrounding cells had undergone necrosis. The basal-cell layer in this area showed slight proliferation. The origin of the cancer in this case is hard to decide. There was no residuum of the lacteal ducts. The clinical course and the fact that the diseased skin was promptly cured by Röntgen rays and that

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after its disappearance the tumor mass was detected beneath the nipple, suggests that the origin of the tumor was under the epidermis and that it could invade the deep layer more easily than before because the protective reaction of the corium had been destroyed by the Röntgen treatment.

CASE VI (Kondoh's Clinic).—Mr. S., aged sixty-five years. Family history negative. Denied venereal diseases. Married at twenty-four. Wife in good health. Six children.

*Clinical History.*—For nine years the patient had had an eczematous condition on the scrotum that was accompanied by severe itching. The diseased area was excoriated and partly eroded. Two years ago he noticed a scab formation on the right scrotum the size of a cent. This he scratched off. The condition at times was stationary, but gradually became worse. Two months previously the centre of the patch was ulcerated and discharged a little serous, foul-smelling fluid.

*Clinical Examination.*—The scrotum was swollen. The left side was excoriated and reddened as though affected with chronic eczema. On the right side, some distance from the radix penis, was a crater-shaped ulcer the size of a half-dollar. Its borders were irregular, raised, elastic and hard. The surrounding skin was bright red, not indurated, but partly excoriated and partly eroded. One part of the foreskin which came into contact with the ulcer of the scrotum showed two small eroded areas, a little infiltrated (Fig. 6). The testicles and epididymis were free from pathologic changes. The femoral and inguinal glands on both sides were enlarged and hardened. The right leg in general was oedematous.

*Operation.*—The penis and scrotum were excised and the lymph-glands were cleaned out July 1, 1914.

*Pathologic Findings.*—In the granulation of the ulcerated part there were many cancer rows, lined by cuboid or columnar cells which surrounded a lumen. The cells stained by Opplar's method showed no eleidin particles. The tumor must be classified as an adenocarcinoma (Fig. 23). The cancerous rows extended into the deep subcutaneous tissues, but were not connected with the testicles. The epidermal layer at the border of the cancerous ulcer showed a proliferation of cells; its border next to the corium had become very irregular (Fig. 22). In this part of the epidermis many Paget cells were found in direct transition from glandular cancer cells. The eczematous area, located some distance from the ulcer, also showed a remarkable proliferation of the epidermal cells. As the greater number of Paget cells were found between the non-proliferating superficial and the proliferating deep epidermal layers, the proliferation of the epidermal cells must be regarded as a reaction caused by the Paget cells similar to that resulting from foreign bodies. No distinct increase of the elastic tissue in the stroma and not much infiltration by the plasma cells were noted. The eroded part of the foreskin was deprived of the cornified layer and showed Pagot cells mingled in the thickened mucous layer. This finding seemed to signify that Paget cells may be inoculated into an epidermal

layer that has been in contact with the original cancer focus. The inguinal glands showed metastases of the type of glandular carcinoma. In this case it was very hard to determine the origin of the cancer. The fact that the carcinoma cells were of glandular-cell type, and that large, long, columnar-shaped groups of cancer cells in the superficial corium ran almost perpendicularly to the ulcerated surface, might suggest that the sweat glands or their ducts were the origin of the neoplasm.

CASE VII (G7776, Mayo Clinic).—Miss M. M., aged thirty-two years. Family history negative.

*Clinical History.*—One and a half years ago the left nipple became irritated and then excoriated. Applications of vaseline were of benefit. One year ago the patient noticed a nodule in the breast. No pain was complained of.

*Clinical Examination.*—The nipple was flattened and ulcerated; the granulations were bright red and there was a slight discharge. The areola directly surrounding the ulcer was in an eczematous condition. The borders of the diseased skin were well defined but not raised. Several hard nodules were palpated in upper outer quadrant. No enlargement of axillary glands.

*Operation.*—Halsted's amputation performed Aug. 14, 1906.

*Pathologic Findings.*—No cancer rows were found in the granulation on the nipple. In the epidermis on the edge of the ulcer, however, were groups of Paget cells which were scattered in the mucous and basal layers of the skin. In the deeper layer beneath the ulcerated surface I found several large irregular ovoid cancer rows, which consisted of glandular cells mingled with large clear cells resembling the Paget cells in the superficial layer. These cancer rows probably originated in a lacteal duct. The Paget cells in the epidermal layer formerly may have had some connection with them which was broken by the reactive hyperplasia of the stroma. The large cancer rows were directly related to the tumor mass in the upper, outer quadrant of the breast, the two foci being connected by numerous small cancer rows. The character of the tumor mass was that of typical carcinoma.

CASE VIII (A15,629, Mayo Clinic).—Mrs. S., aged fifty-eight years. Family history negative. Patient had had four children.

*Clinical History.*—Three years previously the left nipple became cracked and eroded and was cauterized by a physician. This left a hard spot just below the nipple. A year before, the nipple was injured by the corset and again healed slowly. It became more tender and red than before, but the eczematous spot seemed little changed.

*Clinical Examination.*—The left nipple was flattened, ulcerated and bright red, and discharged a little clear fluid. The base of the ulcer was hardened; the areola eroded and sharply defined. In the middle of the breast was a hard nodule, the size of a pigeon's egg, which palpation showed had no direct connection with the diseased skin.

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*Operation.*—October 7, 1908, a Halsted amputation with Jackson's incision was done.

*Pathologic Findings.*—The nipple had been replaced by a cancerous infiltration continuous with the deep layer of the mammary gland. In places, especially on its peripheral portion, the tumor was a distinct papillary carcinoma. On the edge of the ulcer the cancer rows came directly in contact with the epidermal layer. In those parts the transformation of the glandular cancer cells into Paget cells was out of the question (Fig. 12). The skin of the eczematous part of the areola had lost its cornied stratum and the mucous layer, which contained Paget cells, was exposed. The greater the distance from the edge of the ulcer, the smaller was the number of Paget cells. In this case the situation of the lacteal ducts was not distinguishable as the entire nipple had been destroyed and replaced by cancerous infiltration. However, the papillary nature of the tumor might suggest that it had its origin in the milk ducts.

CASE IX (A23,915, Mayo Clinic).—Mrs. S., aged sixty years. Family history negative.

*Clinical History.*—About a year previously, the patient noticed a burning sensation in the left breast and a discharge from the nipple. At about the same time the centre of the nipple became ulcerated. This was improved temporarily by the Röntgen ray. The ulcer had been increasing in size during the last three or four weeks. The eczematous area, including the ulcer, was  $\frac{1}{4}$  inch in diameter.

*Operation.*—The breast was amputated June 2, 1909.

*Pathologic Findings.*—The epidermal layer of the nipple was entirely destroyed and its site was filled by granulation tissue containing a large number of plasma cells and a similar number of eosinophiles and small lymphocytes. A large column of cancerous cells extended almost perpendicularly into the deep layer and was connected with several deep, smaller cancer rows. The carcinoma was of the glandular-cell type. The elastic tissue was greatly increased around the large column and less increased around the small cancer rows in the deep layer. The greater part of the mammary gland, except the above-mentioned degenerated cancerous area, was atrophied. In some areas, however, there was a chronic cystic condition. The eczematous portion of the skin contained a small number of Paget cells scattered in the malpighian layer.

CASE X (A34,572, Mayo Clinic).—Mrs. A., aged forty-eight years. Patient's maternal aunt had had carcinoma of the breast. The patient had borne and nursed four children.

*Clinical History.*—While nursing she had had some pain in the left breast. A year ago a spot appeared on the clothing over the left nipple. For several weeks the nipple had been sore and a raw spot had been cauterized by a physician. Resulting scab came off. After cauterization patient noticed lump in breast.

*Clinical Examination.*—The left nipple was covered by a scab formation the removal of which exposed an eroded surface. No induration on the ground of the patch could be felt. The glandular portion of the left breast was in general firmer than that of the right, but not so hard as in cancer. No glandular enlargement of the axilla was detected.

*Operation.*—Halsted amputation performed Feb. 28, 1910.

*Pathologic Findings.*—The epidermis of the nipple in places had lost the stratum corneum and granulosum, but not all of its layers. In a study of a number of serial sections, I was able to find a lactiferous duct which was cancerous in its most superficial part. Fig. 14 shows that the lactiferous duct increased in size and in the direction of the subcutaneous layer assumed a club-like shape. Near its orifice the border line of the stroma remained more or less intact (except toward the deeper layer) and the elastic tissue was to some extent increased, as indicated by Weigert's stain. In the part nearest the duct the elastic fibres ran parallel to the borderline of the lactiferous duct; at the side they formed an irregular network. The majority of the fibres were rather slender and many of them terminated in sharp points. There was no thick lump of elastic tissue and no granular degeneration. In short, the hyperplasia of elastic fibres was in an early stage. The epidermal layer at the orifice of this lactiferous duct indicated some disturbance of its cell arrangement, and contained a small number of Paget cells. Paget cells were limited in this vicinity, and were directly related to the carcinomatous degenerating epithelial cells of the lacteal duct. There was no transitional form between them and the surrounding epidermal cells. The cancerous degeneration of the lining cells of the lactiferous duct was visible a little deeper and formed several small cancerous rows. The lumina of the smaller milk ducts in the deep layer were dilated here and there, but did not show cancerous degeneration. Sections of the glandular portion of the breast revealed chronic cystic mastitis, but no area of cancer. The restriction of the cancer rows to one lactiferous duct and the limited number of cancer rows proved the condition to be in the earliest stage of carcinoma from the superficial lactiferous duct (Fig. 14).

The most important fact in this case was that only a single lactiferous duct showed cancerous degeneration of its lining cells. This I ascertained by an examination of more than five hundred sections. Other lactiferous ducts showed no pathologic changes. At the most, there was only some dilatation of their lumina and desquamation of the lining cells. It may be stated here that chronic cystic mastitis is a condition that is commonly associated with cancer of the breast. Undoubtedly the chronic irritation of cancer is the cause of this condition in the surrounding glandular tissue.

CASE XI (A42,024, Mayo Clinic).—Mrs. B., aged thirty-six years. Family history negative.

*Clinical History.*—For seven months the patient had had a sore on the left nipple which did not heal. At about the same time an erosion appeared there and gradually enlarged. After a

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while a thickening beneath the nipple was noticed. No subjective symptoms were complained of.

*Clinical Examination.*—The left nipple was bright red and a little retracted. Its centre was slightly eroded. A hard nodular mass was palpated directly beneath the nipple. Several of the lymph-glands in the left axilla were enlarged.

*Operation.*—A Halsted amputation was done August 30, 1910.

*Pathologic Findings.*—The epidermis still remained intact in spots and contained Paget cells in varying numbers. The deeper part of the nipple was almost entirely filled by numerous cancer rows, which did not show any cornification or epidermal pearls. These were connected directly with the cancerous mass in the glandular part. The latter was a scirrhus carcinoma. A direct transformation of cancer cells into Paget cells in the epidermis was noted in several areas where the cancer rows came in touch with the skin layer (Fig. 13). In the enlarged axillary lymph-glands were metastases of scirrhus carcinoma.

CASE XII (A53,174, Mayo Clinic).—Mrs. H., aged fifty-nine years. Family history negative for cancer. Patient had borne and nursed two children.

*Clinical History.*—Three years ago the patient first noticed a scab on the right nipple. This was removed occasionally in bathing. There was no secretion except when the scab was removed. One portion of the nipple was ulcerated and the nipple gradually flattened. Patient had noticed thickening in breast.

*Clinical Examination.*—The right nipple was flattened and showed a scab formation. In some parts there was bright red granulation tissue. The surrounding areola appeared to be affected with an eczematous condition with well-defined borders. A vague thickening was detected on palpation directly under the nipple.

*Operation.*—Halsted amputation performed June 13, 1911.

*Pathologic Findings.*—The skin layer surrounding the ulcer contained a large number of Paget cells, some of which were extraordinarily large and in places formed distinct rows between normal squamous cells (Fig. 9). The latter were strongly compressed by the former and were so slender that they had the appearance of the stroma of connective tissue. In the granulation tissue of the nipple a large, long cancer-cell aggregation extended down vertically into the deep layer, where it connected with many branching and degenerated cancerous milk ducts. This relationship could be confirmed only by examining several hundreds of serial sections. In places the mammary gland had undergone atrophy. An extensive plasma-cell infiltration in the subcutaneous tissue and a noticeable increase of the elastic tissue surrounding the degenerated blastomous milk ducts had the same characteristics in this case as in many others.

CASE XIII (A76,230, Mayo Clinic).—Mrs. A., aged fifty-seven years. An aunt had died of cancer.

*Clinical History.*—About three years previously the patient began to have a slight watery discharge from the left nipple. This was followed by an eczematous condition of the surface. During the preceding six months there had been an occasional slight bloody discharge. No tumor had been detected in the breast. The nipple had not become retracted until six months before. At that time the patient noticed some glandular enlargement in the left axilla. During the preceding spring she had had Röntgen treatment for a month. No pain.

*Clinical Examination.*—The surface of the left nipple was almost entirely eroded, but no open ulcer was visible microscopically. The eczematous condition had spread over the areola in a narrow zone surrounding the nipple. In the glandular part no nodule or thickening could be palpated. The axillary glands were enlarged and hardened.

*Operation.*—The breast was amputated November 26, 1912.

*Pathologic Findings.*—The epidermal layer had disappeared from the greater portion of the nipple and cancer rows were exposed on the surface. The tissue of the nipple itself had been almost entirely replaced by a carcinomatous mass which was connected with a deeper cancer mass by means of many small rows of cells. The rows of cancer cells in the glandular part were enclosed by increased elastic tissue and also by an annular plasma-cell infiltration. In the basal-cell layer and the subpapillary tissue of the eczematous areola, numerous pigment cells were mingled with large lumps of pigment. Some of the Paget cells contained pigment particles in their cell-bodies, perhaps as a result of their phagocytic action. The substitution of unstriated muscle fibres for elastic tissue was unquestionably demonstrated in this case, especially in the surrounding stroma of the cancerous mass of the nipple (Fig. 20.)

CASE XIV (A104,355, Mayo Clinic).—Miss T., aged forty-one years. Family history negative.

*Clinical History.*—A year previously the patient noticed a red spot on the tip of the right nipple. Soon afterward a small nodule developed in the area close to the reddened skin. Several months before a hard spot was detected in the centre of the glandular part.

*Clinical Examination.*—The right nipple was entirely ulcerated. The surrounding areola was eroded in a narrow zone. The nipple itself had been changed into a hard, red tumor-mass, the size of a small nut. In middle of mammary gland some distance from tumor of nipple was another small hard nodule.

*Operation.*—On April 16, 1914, the breast was amputated.

*Pathologic Findings.*—The cornified and granular layers of the epidermis of the nipple had been destroyed. Paget cells were noticed only in the vicinity of the outlet of a lacteal duct. The latter, remarkably enlarged, extended vertically into the deep layer. Its lining cells were in

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complete disorder and their nuclei were irregular in shape; in short, malignant degeneration of the cells was evident. A little deeper beneath the nipple a mass of cancer-cell rows of glandular-cell type was found. The main part of the mammary gland had undergone chronic cystic inflammation. Paget cells were discovered on the edge of the ulcer, which extended nearly to the mouth of a lactiferous duct. This case, like that reported by Thin, affords in its clinical history a suggestion of primary duct-cancer, and in the pathologic findings presents the picture of Paget's disease. There is no longer any doubt that, although in this disease a primary duct-cancer may be limited in its origin to a certain particular part of a duct, it may give rise to the same clinical and pathological conditions as Paget's disease (Fig. 16).

CASE XV (A117,817, Mayo Clinic).—Mr. J. P., aged sixty-seven years. Two years previously the patient injured himself over the right breast on a wagon box. The wound healed in several weeks. Later the skin of the right nipple began to itch. Scratching caused the formation of an ulcer. Perspiration and irritation made it larger. The preceding winter, when he was idle, wound nearly healed, but since then it had been gradually increasing in size. A slight discharge from the ulcer was noticed.

*Clinical Examination.*—The ulcer on the right nipple was bright red, hard and indurated. Its borders were sharply defined, but not elevated. Directly beneath the ulcer and attached to it was a tumor-mass the size of a hen's egg. No other nodule or thickening was to be discovered in the glandular part. The axillary glands were not enlarged.

*Operation.*—Halsted's amputation performed Nov. 12, 1914.

*Pathologic Findings.*—The granulation tissue which formed the ulcerated part of the nipple was mingled with numerous small rows of cancer cells, some of which surrounded lumina lined with cylindrical cells. The eroded area of the skin surrounding the ulcer was characterized by decided degeneration of the epidermal cells mingled with Paget cells. The difference between the degenerated epidermal cells and Paget cells was evident in this case, because the cell-bodies of the former were destroyed and had lost the staining qualities of their nuclei. The latter still retained the distinct contour of their cytoplasm and contained one or two densely-stained nuclei, showing in places mitotic figures.

CASE XVI (A128,147, Mayo Clinic).—Miss R., aged thirty-seven years. The patient's mother had had cancer of the breast.

*Clinical History.*—Five years before, the patient had noticed a slight discharge and a scab formation on the right nipple. When the scab fell off, the nipple showed a superficial erosion, and discharged a little bloody fluid. The scab formed again quickly, but fell off every four or eight weeks. No pain.

*Clinical Examination.*—A scab covered the tip of the right nipple. When this scab was removed a small granulating ulcerated



surface was exposed. The skin of the nipple was excoriated and tender and on pressure exuded a little bloody pus. No induration was discovered in the mammary gland.

*Operation.*—On June 4, 1915, the right breast was excised.

*Pathologic Findings.*—The epidermal layer had disappeared from the greater portion of the nipple and had been replaced by granulation tissue which contained numerous rows of cancer cells. Thick and dense elastic fibres were scattered through the stroma. Some of the rows of cancer cells connected with the basal layer of the skin had encroached upon it, taking the form of Paget cells (Fig. 15). In the subpapillary layer, directly beneath the eroded skin of the areola, were many transverse, ovoid and remarkably dilated blood-vessels. The dilatation was due to compression by the cancerous infiltration just below. It is perhaps because of these dilated blood-vessels under the epidermis that the eroded skin is of such a bright red color in this disease (Fig. 11). The tumor in this case was a glandular-cell carcinoma.

CASE XVII (A134,558, Mayo Clinic).—Mrs. T., aged fifty-two years. Family history negative.

*Clinical History.*—A few years ago the patient noticed a small bloody stain on the clothing covering her chest. Up to three months before she had noticed this every month. In the previous three months and especially in the last month, a little pus had been discharged from the nipple. No thickening or nodule could be detected at that time. For several months erosion and crack formation had been noticed on the nipple. Six weeks previously a small lump developed in it. Wound slightly sore.

*Clinical Examination.*—The left nipple was generally injected, in places eroded, and showed several deep cracks. The surrounding areola was excoriated in a narrow zone. The nipple was hardened. No tumor formation was detected in the glandular part. The axillary glands were not enlarged.

*Operation.*—Halsted's amputation performed June 30, 1915.

*Pathologic Findings.*—This is the second case in which primary duct-cancer is suggested by the clinical history. However, the subsequent course of the disease and the pathologic findings showed it to be genuine Paget's disease. The results of the histologic examination were almost the same as that of Case XIV. I believe that the appearance of the Paget cells and the consequent alterations of the epidermal layer are parallel to the degree to which the glandular cancer cells have migrated into the epidermal layer. The fact that Malinowsky and others were not able to find Paget cells in their so-called pseudo-Paget's disease, was due simply to a lack of migration of the cancer cells into the epidermis. In other words, if cancer cells from the deep layer had encroached on the epidermal layer, as in my two cases, there would have been no greater difference between the clinical and histologic findings in that case and those of the genuine (precancerous) type of Paget's disease (Fig. 7).

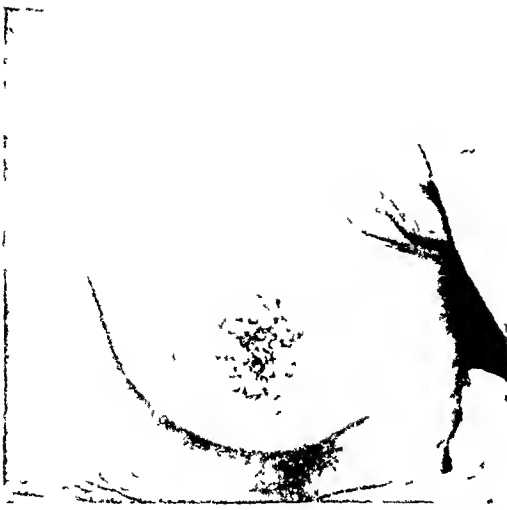


FIG. 1.—Case III. Mrs. O., Kondoh's Clinic. Paget's disease of the nipple.

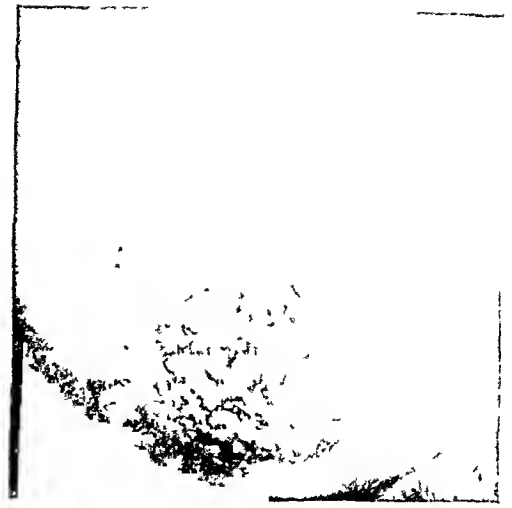


FIG. 2.—Case IV. Mrs S , Kondoh's Clinic. Paget's disease of the nipple.



FIG. 3.—Case V. Mrs. I., Kondoh's Clinic. Paget's disease of the nipple. Photograph taken before Röntgen ray treatment.

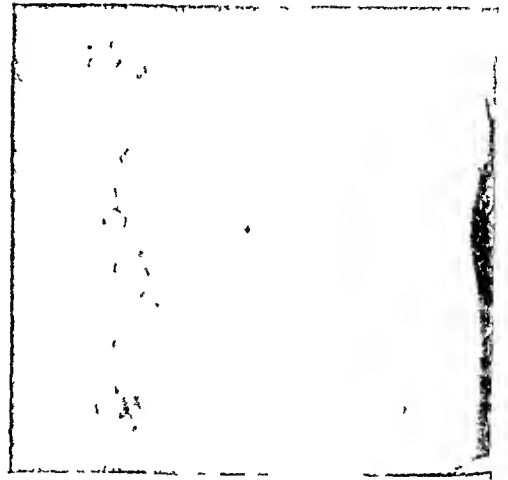


FIG. 4.—Case V. Mrs. I., Kondoh's Clinic. Paget's disease of the nipple.

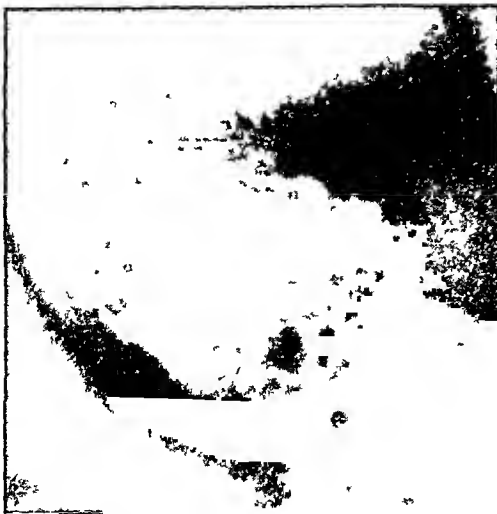


FIG. 5.—Case V. Mrs. I., Kondoh's Clinic. Paget's disease of the nipple. Temporarily healed condition of the diseased skin. Depigmentation left after the disappearance of the dermatitis.



FIG. 6.—Case VI. Mr. S., Kondoh's Clinic. Apparent carcinomatous ulcer-formation after long-continued extramammary Paget's disease. Cancerous crater on the right scrotum. Left part shows an eczematous condition. Penis in paraphimosis.



FIG. 7.—Case XVII. Paget cells scattered in the epidermal layer. The latter proliferated.

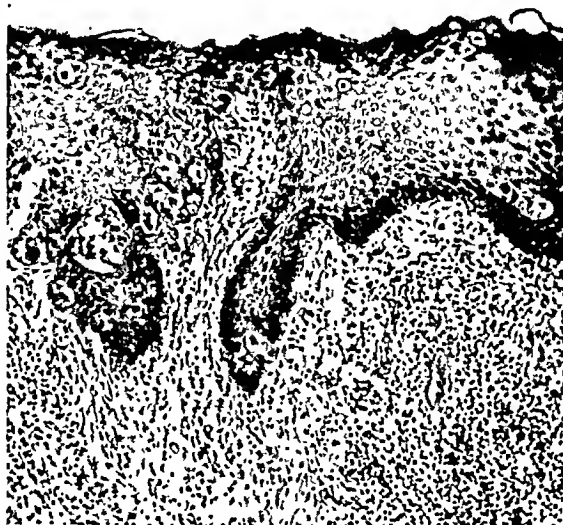


FIG. 8.—Case IX. Paget cells in the epidermal layer. The stratum corneum has fallen off.

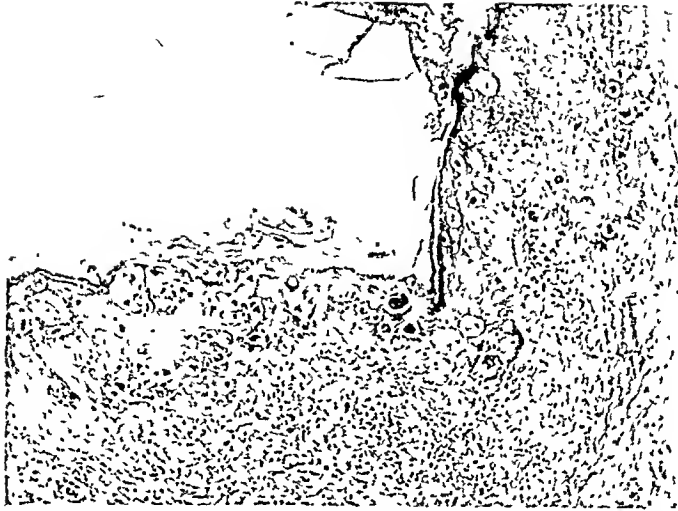


FIG. 9.—Case XII. Eczematous area of the skin, showing many Paget cells in the epidermal layer. These cells caused the proliferation of the epidermal layer (right) and destroyed the latter (left).

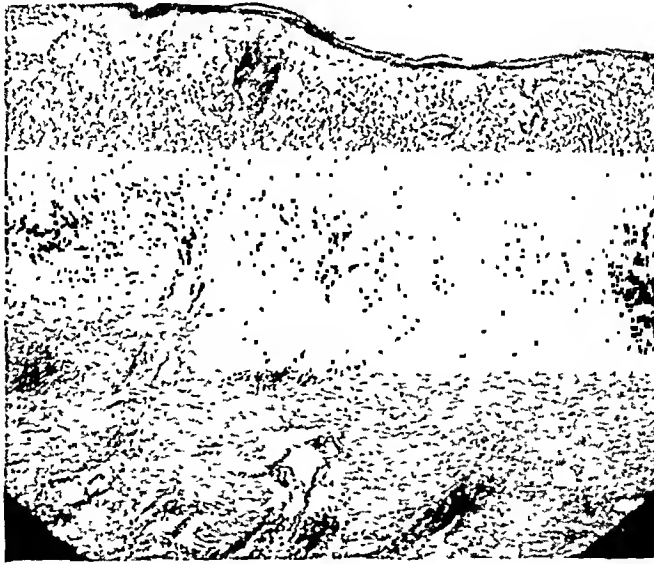


FIG. 10.—Case XVIII. Plasma-cell infiltration in the superficial corium.

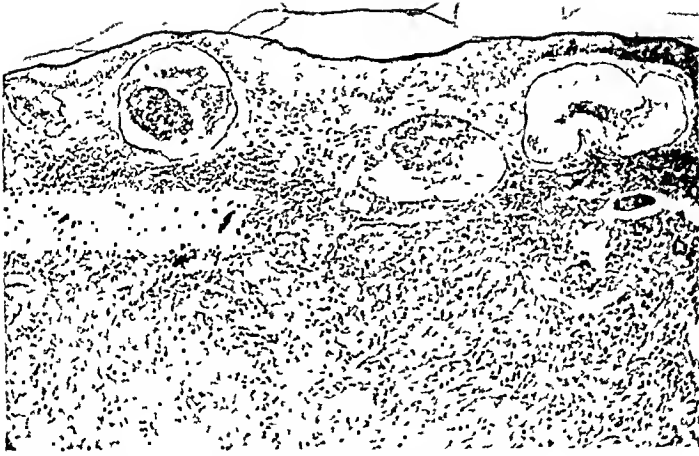


FIG. 11.—Case XVI Dilated blood-vessels in the subpapillary part of the corium. Cancerous infiltration below.



FIG. 12.—Case VIII. Section of the edge of an ulcer of the nipple. *a*, thickened epidermis; *b*, papillary carcinomatous rows.

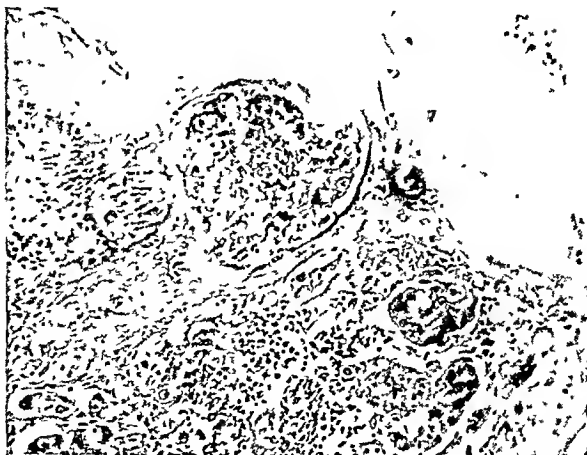


FIG. 13.—Case XI. The cancer rows coming into contact with and entering the epidermal layer and taking the form of Paget cells.

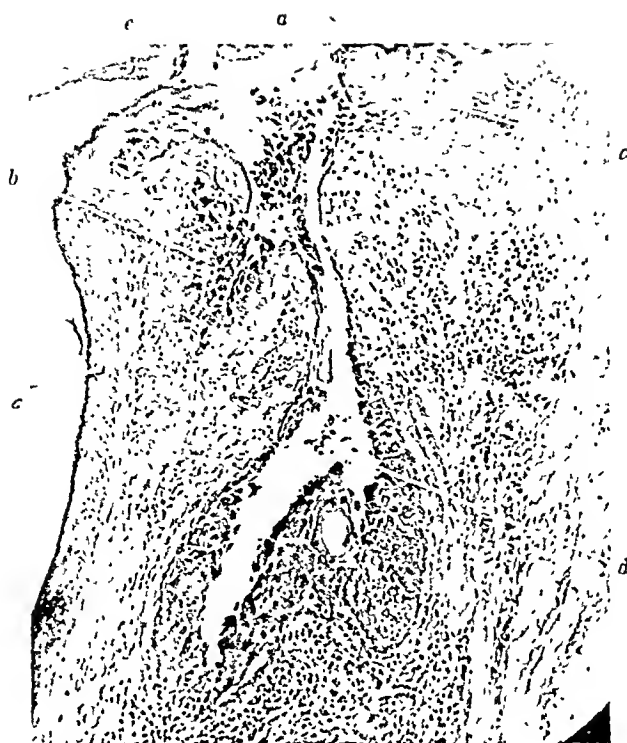


FIG. 14.—Case X. A superficial lactiferous duct showing cancerous degeneration and cancer cells making their way into the epidermis. These glandular cancer cells take the form of Paget cells. *a*, the orifice of the lactiferous duct; *b*, the cancer cells making their way into the epidermis; *c*, the epidermis layer of the nipple; *d*, the cancerous degenerating superficial lactiferous duct; *e*, the desquamated epidermis.

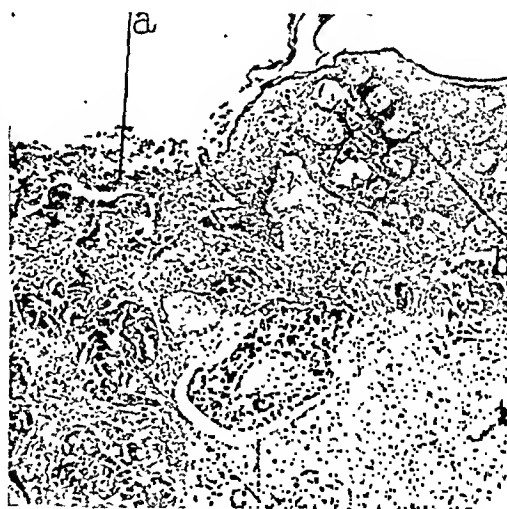


FIG. 15.—Case XVI. The edge of the ulcer of the nipple; *a*, the surface of the ulcer in the site of the nipple; *b*, thickened epidermis containing Paget cells; *c*, cancer rows.

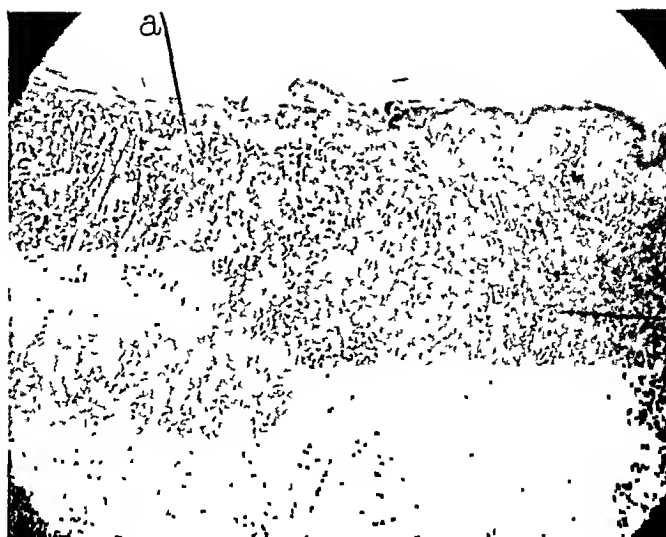


FIG 16 —Case XIV The vicinity of the orifice of the cancerous degenerating lactiferous duct  
*a*, epidermal layer thickened and invaded by Paget cells, *b*, granulation tissue in the corium, with plasma-cell infiltration, *c*, cancerous degenerating lactiferous duct



FIG 17 —Case IV. Milk duct in the deeper layer One part of its wall (right) retained the normal structure (two-layered columnar cells), the outer part of the wall (left) is changed to a cancer formation The milk duct below shows a dilated lumen, but no cancerous degeneration of its lining cells

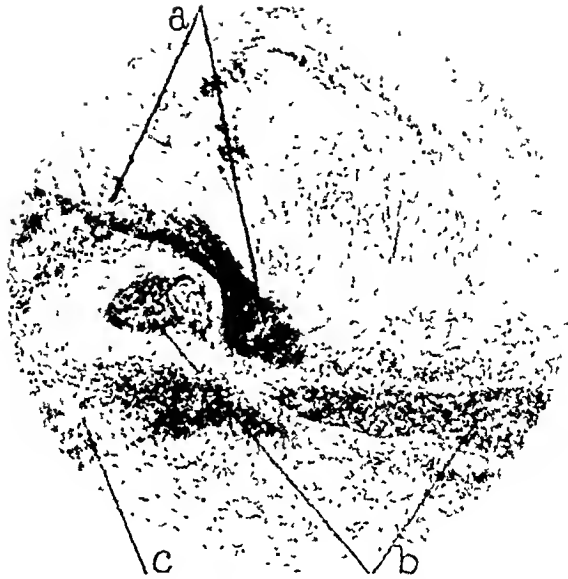


FIG. 18.—Case IV. Cancerous degenerated milk duct surrounded by plasma-cell infiltration and reacted upon by the hyperplasia of the elastic tissue. (Weigert's elastica stain+ lithium-carmin). *a*, increased elastic tissue; *b*, cancerous degenerated milk duct encircled by plasma-cell infiltration; *c*, elastic tissue.

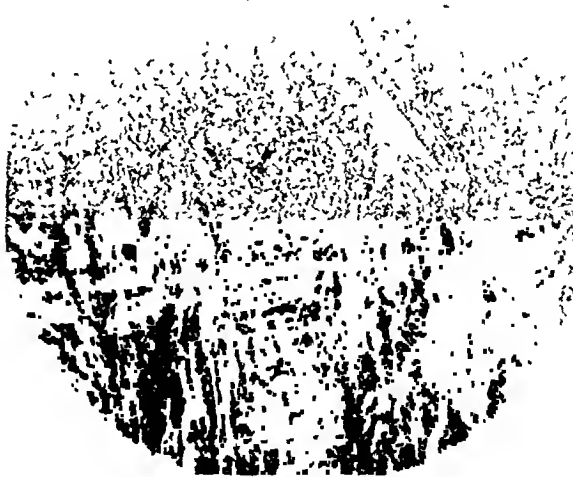
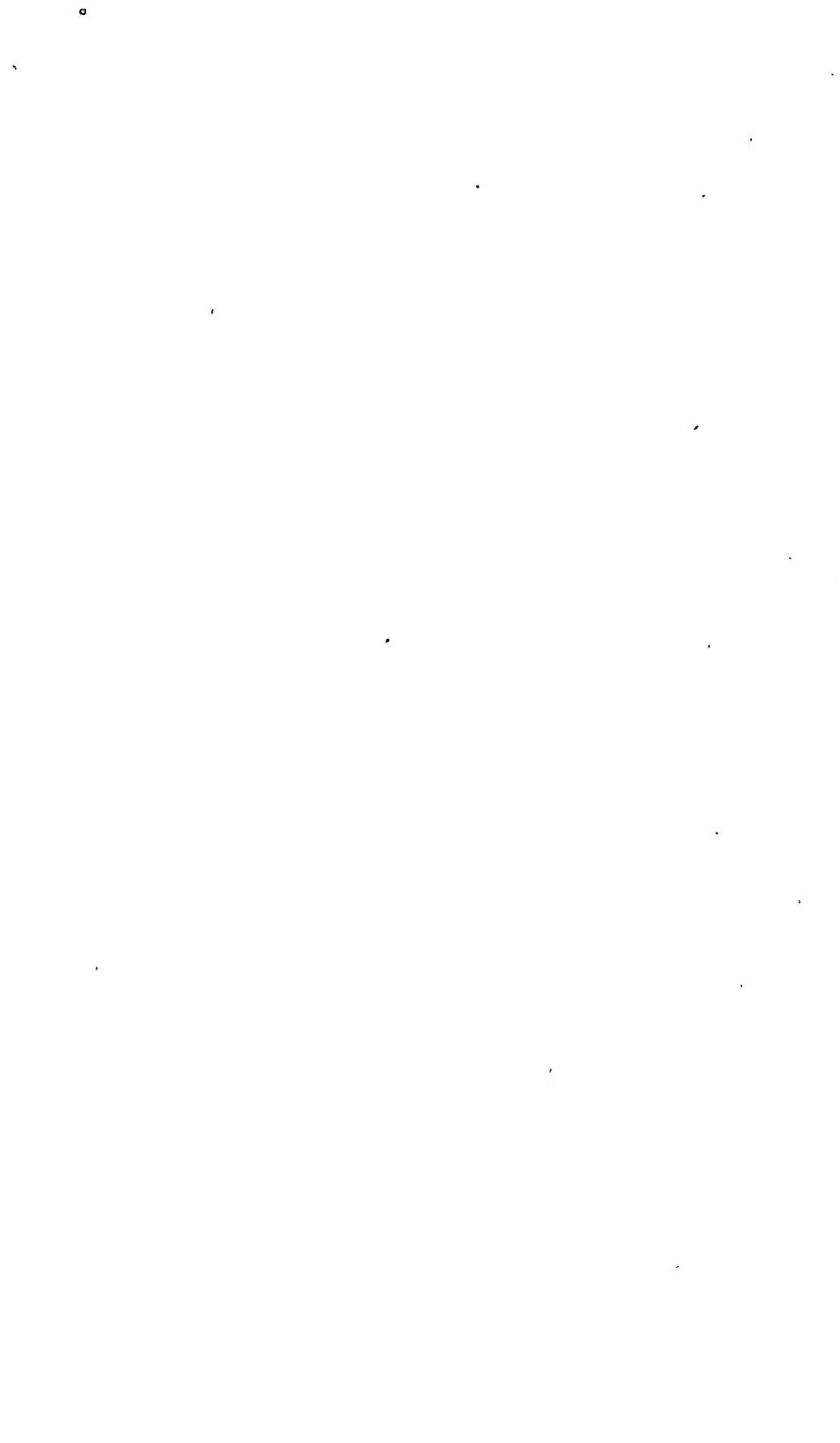


FIG. 19.—Case IV. Exceptional hyperplasia of the elastic tissue in the corium of the nipple. Most of the elastic fibres run vertically.





## PAGET'S DISEASE OF THE NIPPLE

CASE XVIII (A136,962, Mayo Clinic).—Mrs. K., aged forty-four years. Family history as regards cancer negative. Patient had given birth to and nursed two children.

*Clinical History.*—About three years previously, the patient noticed a small abrasion on the left nipple, which enlarged very slowly. One year before she was treated by Röntgen rays and the affected skin seemingly healed up. Several months previously the eczematous condition came on again, and the nipple occasionally became encrusted. At the same time a small indefinite thickening in the glandular part developed.

*Clinical Examination.*—The left nipple was abraded, its tip ulcerated, bright red, and slightly weeping. Eczematization spread over the surrounding areola. The margins of the patch were sharply defined. The ulcer itself was not indurated, but in the upper inner quadrant was an indefinite thickening in the subcutaneous layer and some atrophy of the cutaneous tissue. No glandular enlargement in the axilla was detected.

*Operation.*—On July 27, 1915, complete amputation of the left breast was done.

*Pathologic Findings.*—The granulation tissue in the site of the nipple consisted of fibroblasts, newly-formed small blood-vessels and extensive plasma-cell infiltration, mingled with eosinophile cells and lymphocytes (Fig. 10). In the deeper part were many rows of cancer cells surrounded by elastic tissue and annular plasma-cell infiltration. A large, long column of glandular cancer cells which extended down into the tissue nearly vertically may have been a cancer-degenerated lacteal duct. Paget cells were numerous in the areolar skin. However, in this case no relation between the Paget cells and the rows of cancer cells could be discovered, even in numerous serial sections. Perhaps this condition was secondary, and due to a reactive hyperplasia of the stroma. Such an hypothesis might be justified by comparing these findings with those of other cases just reported. The subcutaneous thickening in the upper inner quadrant was a scirrhous carcinoma which seemingly did not have any direct connection with the cancer rows beneath the nipple. It is probable that it was caused by metastasis through the lymph-spaces. Although atrophy of the skin was noted clinically, the epidermal layer was not in direct contact with the cancer rows, but was separated from them by a narrow zone of dense connective tissue.

### SUMMARY OF PATHOLOGIC FINDINGS

From the pathologic findings of these cases, the points necessary to give a general idea of the affection are summarized below:

*Epidermis.*—In the epidermis I found, in general, two different types of alteration—the one a thickening, the other a thinning or destruction. The thickened part of the epidermis for the most part surrounds the edges of an ulcerated or eroded area and shows proliferation of the cells of the malpighian layer. The thinning is usually at the expense

of a cornified or granular layer. In both places, peculiar large and clear cells, so-called Paget cells, are seen mingled. The number varies in different cases. These cells are always larger than normal epidermal cells, sometimes double or three times their size, distinctly round, or slightly oval. In fixed sections they are doubly contoured, but in fresh frozen sections cytoplasm completely fills the capsule. The cytoplasm is homogeneous, but at times contains variously shaped vacuoles. There may be one or two nuclei. The chromatin stains very densely. Karyokinesis may often be observed. No epithelial fibrillation and no prickles are visible. Eleidin particles are not present. Darier calls these cells "cellules dyskeratosiques." It is a question, however, whether as degenerated epidermal cells they have lost the faculty of keratinization or whether they never had it from the beginning. This will be discussed later on. Cells of this type are most numerous in the malpighian layer of the eczematous area, especially at the edge of the ulcer, somewhat fewer in the basal-cell layer and rare in the superficial cornified stratum. Even in the latter, they do not show any tendency to cornification. I would emphasize the fact that in the early stage of this affection Paget cells are found in the largest numbers in the neighborhood of the outlets of the lacteal ducts (Fig. 16). They are found also to a certain extent deep in the walls of the lacteal ducts which show cancerous metamorphosis of the lining cells. In the advanced stage of the disease, they are scattered widely in the epidermal layer, sometimes forming distinct rows. They flatten the surrounding normal epidermal cells, giving them the appearance of stroma between rows of clear, large cells. Often the basal cells are extremely compressed and become very flat and linear, forming a boundary line between the epidermis and the corium. From their characteristics, I cannot believe with Unna that Paget cells are simply degenerated epidermal cells or epithelial oedema. Active karyokinesis, compression of the surrounding cells, the maintenance of form even in the cornified stratum, in short, such increased vitality, cannot be explained as being the result of regressive metamorphosis of the ordinary epidermal cells. On the other hand, however, they never show any tendency to invade the corium and I have never noted apparent transition from Paget cells into squamous epithelial cancer-cells. This is the difficulty in accepting the opinion of Karg and Krogus, who call these cells "erste Krebszellen," meaning the very first anaplastic epidermal cells degenerating *in loco*. I have no doubt that Paget cells are tumor cells, but I do not believe they originate in the local epidermis. The grouping of these cells in the outlets of lacteal ducts in the early stage of the disease and their vacuolated, seldom fatty, degeneration, lead me to the opinion that they are tumor

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cells which have migrated from the cancer-degenerated lacteal duct and have undergone some regressive metamorphosis during the migration in the intercellular lymph-channels, which has lessened their invading power. This conclusion is in agreement with the clinical fact that the eczematous change of the skin is almost always limited to the area surrounding the nipple. Only in very rare instances does it extend beyond the areolar region. Hammemuller and Landois assume that the chronic granulation tissue due to the long-continued cancerous invasion in the corium, is responsible for the degeneration of the epidermis, altering the osmosis and diosmosis of the cells. If this supposition is true, the second question is yet to be answered, viz.: Why is it that such a comparatively small number of cells change into Paget cells and increase their vitality while the surrounding epidermal cells do not show any transition to the former? Some authors believe that the transition of epidermal cells into Paget cells occurs frequently. However, I have noticed that epidermal cells often undergo vacuolation from the encroaching Paget cells, and at the same time lose the staining of the nuclei. If the sections are thin enough, it will be found also that in form they are quite different from the typical Paget cell. Figs. 7, 8 and 9 illustrate this difference clearly. In several instances I have found large clear cells of the basal-cell type, much like Paget cells, at the edge of cancerous ulcer of the lip. The same cell may be observed also in the neighboring epidermal layer of the nævocarcinoma, as has been noted by Audry, Hartzell and Kreibich. Such facts are proof that if cancer cells, which do not possess the tendency to cornification, migrate into the intercellular lymph-channels of the surrounding epidermal layer and suffer degeneration of their cell-bodies, they also may be similar to Paget cells. The same explanation may be applied to the findings in my case of extramammary Paget's disease. In the latter, the origin of the cancer was thought to be in the sweat glands or their ducts and the transition from glandular cancer cells into Paget cells at the edge of the ulcer was clearly observed. At the first step of the invasion into the normal skin layer, Paget cells act like foreign bodies, causing a stimulation which results in a proliferation of the epidermal cells and accounts for the thickness of the layer in such places. Afterward they increase in number by mitosis, migrate further, compress the normal epidermal cells, and finally destroy the skin layer to the ulcer.

In my fifth case, which was treated by the Röntgen ray, and in which the condition recurred after temporary healing in one spot of the areola, and was accompanied on its return by tumor formation in the deep layer, I found Paget cells in the recurrent, reddening part of the skin, and noted that the cells of the malpighian layer were degenerated

or destroyed. The explanation of this fact is, that while the migrating tumor-cells were almost exterminated by the Röntgen ray, some were left undisturbed in latent vitality, the intensity of which was recovered later and again caused the destruction of surrounding epidermal cells.

Next, we must study further the relation between Paget cells and melanoblasts. In many cases pigment cells are really increased in the border of the normal skin near the eczematous area. Moreover, in my fourth case, the integral pigment cells and the lumps of broken pigment were scattered in the mucous layer of the eczematous part where many Paget cells were collected in rows. Some of them contained bits of pigment which seemed to have been absorbed by the phagocytic action of the cells. There was no transitional form between the melanoblasts and the Paget cells. I could not find any positive evidence in any case to justify Kreibich's opinion that melanoblasts change into Paget cells, having lost the faculty of producing pigment and lipoid.

*The Corium.*—The noticeable alterations in the corium are: (1) the infiltration of plasma cells, and (2) the hyperplasia of the elastic tissue. It is generally known that plasma cells are often to be seen in mammary tissue which is in physiologic condition, especially in the stroma surrounding acini. In Paget's disease the plasma-cell infiltration in many cases is remarkable in the subpapillary layer of the corium, *i.e.*, between the epidermal layer and the subpapillary elastic net, the latter forming the borderline of the infiltration (Fig. 10). Very often it extends to the deeper corium, below the borderline. The rows of cancer cells in the glandular part are sometimes enclosed by an annular infiltration. In the very early stage of this affection, however, there is often no noticeable infiltration of these cells. As a rule, the longer the duration of the disease, the stronger the plasma-cell infiltration. These cells are often mingled with lymphocytes, eosinophile cells or mast cells. When there is a mixed infection and polymorphoneutrophile cells invade the tissue in large numbers, the number of plasma cells seems to be decreased. The chief characteristics of plasma cells are the cytoplasm with basophilic granula, which are large, round and polygonal in shape, and eccentrically placed nuclei which are stained less densely by polychrome-methylene blue than cytoplasm. Little is known in regard to the matrices of the cells. Unna observed them in abundance in the connective tissue and about the vessel in cases of chronic inflammations, especially lupus. He assumes that they are derived from fibroblasts and destined to degenerate finally into epithelioid or even giant cells. Marshalko found them in normal tissue lying free in the lymph-glands and the spleen, and ascribed their origin to hæmic lymphocytes. He did not accept Unna's opinion that they are derived from connective-tissue

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cells, and change into epithelioid cells. Schottlander believes that plasma cells originate from hæmic elements while they resemble fibroblasts and might form granulation tissue and epithelioid cells. Hodera distinguished two kinds of so-called plasma cells—one, the true plasma cells, which are developed from the fixed connective-tissue cells, and the other, the pseudo-plasma cells, which are derived from hæmic elements. Krompecher claimed that plasma cells are an intermediate stage in the metamorphosis of wandering hæmic cells into fixed connective tissue. Ribbert insisted that plasma cells originate from normal minute lymph-nodes, which produce them abundantly when stimulated by some inflammation. Marchand suggested that plasma cells arise from the breaking up of large amœboid phagocytic cells, which in turn are developed in inflammatory conditions from adventitial cells. Whitfield claimed that the subdivision of the endothelium of the smallest central vessels of the lymph-nodes is the source of plasma cells. This problem cannot be solved with our present data. However, it seems to me that in some cases it is very probable that the plasma cells are derived from adventitial cells of vessel-walls, since in the early stage of the infiltration such a transitional development is no longer to be doubted. On the other hand, I am not ready to deny positively their hæmic origin. Many authors at present seem to accept a dual genesis of these cells.

I will consider now the hyperplasia of the elastic tissue. We sometimes note in slowly advancing, long-continued scirrhus carcinoma, a tremendous increase of elastic tissue, as if the entire stroma has changed (so-called elastocarcinoma). In Paget's disease the same phenomenon is often decided. The subpapillary elastic net, which in the normal condition occupies the borderline of the basal layer, is increased more or less under the eczematous area of the skin, and pushed down deeper by the plasma-cell infiltration, as I have already described. The most striking feature is seen in the corium of the nipple. The vertically-running elastic fibres sometimes take the place of muscle and connective tissue (Fig. 19). In the deeper subcutaneous layer, the elastic fibres show an increase in thickness and number, and here and there form thickly-stained irregular lumps. The cancer-degenerating milk ducts are usually encircled by a heavy ring of the elastica, which seems to have some defensive action against the proliferation of tumor cells. Granular degeneration of the elastica, as described by Fischer, is often noted. If we examine only the advanced stage of the increase in the elastica, we may receive the impression that it may have been formed from connective tissue and muscular tissue by metaplasia. As the result of careful study of various gradually advancing cases, however, I have been led to the conclusion that this tissue is increased, not by metaplasia, but

by continuous hyperplasia and hypertrophy of the pre-existing elastic fibres. Not only the subpapillary and subcutaneous elastic network, but more noticeably the elastic fibres contained physiologically in the walls of the milk ducts, vessels, the perimysium of the unstriated muscle fibres, and the perineurium of the subcutaneous nerves, by increasing, by branching and thickening, as a reaction against the slowly progressing, destructive agents, sometimes make overcompensation and substitute another tissue. The densely-stained elastic lumps which I have often seen in stroma could be traced in serial sections to degenerating unstriated muscles, vessels or nerves, which are replaced by elastica.

*Lactiferous Ducts.*—Interest from a pathologic standpoint centres in the condition of the lacteal duct. Since Thin assumed the affection to be primary milk-duct cancer, many authors (Hallopcau, Barling, Mandry, Jacobæus, Schambacher and others) have concurred in his opinion. Moreover, those who believed the affection to be superficial epithelioma (Vidal, Svetsitski and others) or precancerous disease (Wickham, Hartzell and others) observed proliferation of the lining cells of the superficial milk ducts even in very early stages of the disease (Jopson and Speesc). To decide whether the alteration of the lacteal duct is primary or secondary, we must examine the condition in its very early stage, because in advanced cases the epidermis of the nipple is dropped off, and the condition of the superficial lacteal ducts is no longer distinguishable as the ducts have been replaced by cancerous granulation. In my observation of the early period—in one case for several weeks, in a second for seven months, in a third for ten months, and in three for one year after the eruption of the nipple—I always found a peculiar proliferation and desquamation of the duct epithelium in its superficial part, accompanied by irregularity of the shape of the cells. Fig. 14 gives undisputable proof that the proliferation of the duct epithelium is not secondary to the skin affection, but a primary cancerous degeneration of the orifice. The objection may be raised that the proliferating epithelium has not infiltrated into the surrounding stroma and caused alveolar formation. This, however, is due, first, to the early stage of the cancer development, and, second, to the peculiar anatomical structure and condition of the stroma of the nipple. The nipple, as is well known, contains many involuntary muscle fibres which not only give more resistance than connective tissue, but can be compensated by elastic tissue if it undergoes parenchymatous degeneration by invading cancer. This being true, the alveolar formation of cancer in the nipple in the early stage is particularly difficult as compared with a similar formation in the subcutaneous tissue of other parts. I examined frozen sections of the nipple from over one hundred cases, paying

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special attention to the superficial milk ducts in carcinoma of the breast, fibro-adenoma, and chronic cystic mastitis. In some cases, especially in mammary cancer located near the nipple, two types of reactive proliferation of the lining cells of the lacteal ducts were noted: (1) Villous proliferation of the epithelium only, and (2) papillary proliferation, *i.e.*, epithelial hyperplasia accompanied by connective-tissue increase. I have never found such epithelial proliferation with irregularity of cells and marked hyperplasia of the surrounding elastic tissue as is found in early Paget's disease. Although the source of stimulation in the former cases was in the deep layer and not in the outer skin, which some authors believe to be the case in a precancerous condition, the reactive phenomenon of the lacteal ducts in both cases seems to be analogous. Therefore, I should say that the epithelial alteration of the superficial lacteal ducts in early Paget's disease cannot be explained as being simply reactive proliferation due to stimulation, but in reality, is primary cancerous degeneration. In this disease the epithelium of the superficial lacteal ducts from the very beginning shows cancerous degeneration, which invades the epidermis, causing the skin affection, and the deep layer, forming typical cancer rows where the resistance and reaction of the stroma is weaker than that of the nipple (Fig. 17). This conclusion, which agrees with the observations of Jacobæus, is in agreement also with the clinical fact that in many cases the tumor formation takes place beneath the nipple about in the centre of the mammary gland, a clear space intervening between the affected skin and the tumor.

In general, the duct cancer is relatively less malignant, as it encroaches on the surrounding tissue slowly and metastasis occurs at a late stage. That Paget's disease may be a very slowly developing glandular-cell carcinoma from the superficial lacteal duct is not an unreasonable supposition. It is analogous to the basal-cell carcinoma which, as compared with the ordinary squamous-cell epithelioma, does not show distinct malignancy for some time. Some clinicians may oppose this opinion, since signs of cancer may be found clinically in the early, so-called eczematous stage of this affection. However, I dare say that five of my eighteen cases in which histologic examination revealed cancer of the superficial lacteal duct, were in just such an eczematous, so-called precancerous condition in which no clinical symptoms suggested the carcinoma. No longer can there be any question as to its nature, since Case X, even as early as a few weeks after the appearance of the eczematous patch, showed the beginning of cancer of the duct orifice. In this connection, still another point should be mentioned. The number of lacteal ducts showing cancerous degeneration of their lining cells is *not* large. In Case X the origin of cancer was limited distinctly to one



duct. Therefore, the entire area of the diseased nipple should always be studied by many serial sections or important facts may be overlooked in the examination of the early stage.

Case 6, in which the scrotum was affected by the disease, was in too advanced a condition to permit a decision as to the origin of the cancer. Nevertheless, the findings which showed that the cancer was of the glandular-cell type, containing lumina, and was invading the epidermal layer and changing into Paget cells, were similar to those in the cases in which the disease affected the breast, and it would not be absurd to suppose that the sudoriferous duct acted the part of the lacteal duct. Crocker, Rolleston, Hunt, and others, have already described the sweat glands as the origin of cancer in cases of extramammary Paget's disease. It is well known that embryologically the mammary glands and the sweat glands are similar. Recent authorities have concluded that embryologically the breast should be classed with the sweat glands, although the older writers believed that it was a modified sebaceous gland. Not only does the milk gland resemble the sweat gland closely in the manner in which it was developed, but in the adult condition its sudoriferous character is implied by (1) its hydradenoid structure, represented by the two-layered epithelium of the ducts and the simple epithelium in the glandular alveoli, and (2) the fact, that although in the milk gland there is no fatty metamorphosis of the central cells as in the sebaceous glands, there is a secretion from the gland-walls, as in the sweat glands. In the development of both glands, the deep layer of endoderm (stratum cylindrosum) becomes thickened by the multiplication of its cells at the site of future glands, the thickened patch encroaching upon the underlying corium (Fig. 24). The epithelial ingrowth enlarges and cornifies gradually in its central portion, and part of it falls out, so that the ingrowth becomes hollow and changes into acini. Therefore, the epithelial cells in such a mammary bud may differentiate into two types with different functions, *i.e.*, the cover epithelium and the glandular epithelium. The superficial part of the ducts of these glands, especially of the lacteal ducts, shows a trace of this embryonic condition in the post-natal periods; the lining epithelium in this part shows either double-layered cylindrical cells or many-layered non-cornifying squamous cells. If carcinoma means the reversion of epithelial cells into undifferentiation *in loco*, it should be well understood that Paget's disease regarded as a primary glandular-cell cancer of the lactiferous duct shows some resemblance to cover-epithelial carcinoma.

From the above considerations, I am led to the opinion that *Paget's disease is primary carcinoma of the orifices of the lactiferous or the sudoriferous ducts.*

## PAPILLOMA OF THE UMBILICUS\*

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AN examination of the literature for papilloma of the umbilicus shows very few reported cases. Cullen, in his recent work, "The Umbilicus and Its Diseases," was able to collect only eleven well authenticated reports. Fabricius von Hilden, in 1526, published the first recorded case of this kind, and since then a few isolated cases only have been published, and most of these have not been considered reliable, because no microscopic examination had been made in the majority of them, and the gross picture was, therefore, not satisfactory.

Most of these tumors have been noted between the twenty-fifth and fiftieth years, although Broussolle reports a typical papilloma in a child five months old.

An examination of the reports shows that papillomata of the umbilicus occur in about equal frequency in the male and female, but Cullen does not consider the number, so far reported, of sufficient frequency to reach a definite conclusion in this regard.

As a rule these tumors are pedunculated, but in one reported by Péraire, the growth had spread out for a considerable distance into the abdominal wall.

These tumors are generally of slow growth, and vary in size from 5 mm. in diameter to that of a walnut, and are said to occur most frequently in persons of filthy habits.

In studying the recent work of Cullen, in which he has without doubt collected all, or most of the published reports, I am convinced that there must have been a number of these tumors which were not recognized as such, as diseases of the umbilicus have not received the attention that they were entitled to, until the publication of Cullen's very complete work on that subject. In my practice I have seen tumors in this situation, the diagnosis of which I have been unable to make, as no operation was allowed, because the tumors were small and giving no trouble.

The following case of papilloma of the umbilicus came into my service at the Barnard Free Skin and Cancer Hospital, last year, and on account of its rarity I have thought it of sufficient interest to report to-night.

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\* Read at the meeting of the St. Louis Surgical Society, October 11, 1916.

When the patient entered the hospital, the tumor was about the size of a hickory nut, of irregular surface, dipping down into the umbilical canal, giving it the appearance of growing around a tube. This surface was of a dark grayish color, and appeared like a large wart. The picture, here presented, taken at the time of entrance of the patient into the hospital, gives very distinctly the gross appearance of the tumor at that time.

*History.*—A. C., aged seventy-seven; male; occupation, laborer; white. Admitted to hospital October 25, 1915.

*Past History.*—Patient has always lived in the country, and done outdoor work. Has had three children, all of whom died in youth. No history of lues. Patient has always had good health, except one attack of jaundice and fever a few years ago.

*Habits.*—Irregular and filthy.

*Present Illness.*—About a year ago patient noticed a small mass, the size of a dime, at the umbilicus (Fig. 1). This has never ulcerated, has not been very painful, and there is no history of injury. Recently the tumor has been increasing in size, although the patient thinks it has been larger than it is at present.

*Physical Examination.*—Patient is a fairly well developed man. General appearance very anæmic. Mucous membranes are pale. General examination negative, except for a slight swelling of the right ankle. At the umbilicus there is a hard, irregular indurated mass surrounding the opening. This is not ulcerated, appears to extend deeply but does not seem to invade the surrounding tissue. There is no evidence of hernia, or other abdominal masses. The liver is about four finger breadths below the costal region; spleen not felt. Examination of rectum, negative.

*Operation* (October 28, 1915).—Region around the umbilicus was infiltrated with 1 per cent. novocaine. An elliptical incision about 5 cm. in length surrounding the tumor was made transversely across the abdomen. This was carried down to the peritoneum. It was found that the tumor did not extend into the abdomen, but seemed to be limited to the umbilicus. The peritoneum was opened, and a piece of omentum was found attached to the abdominal wall. An exploration of the abdomen did not reveal anything abnormal. The peritoneum was closed with a catgut suture; the fascial layer was overlapped from above downward, interrupted catgut sutures being used. The wound was closed with catgut and interrupted silkworm-gut sutures.

*Post-operative Course.*—Uneventful, except that the patient had a slight attack of arthritis in the right knee. The wound healed very satisfactorily, and the inflammation of the joint has had local treatment.



FIG. 1.—Papilloma of umbilicus.

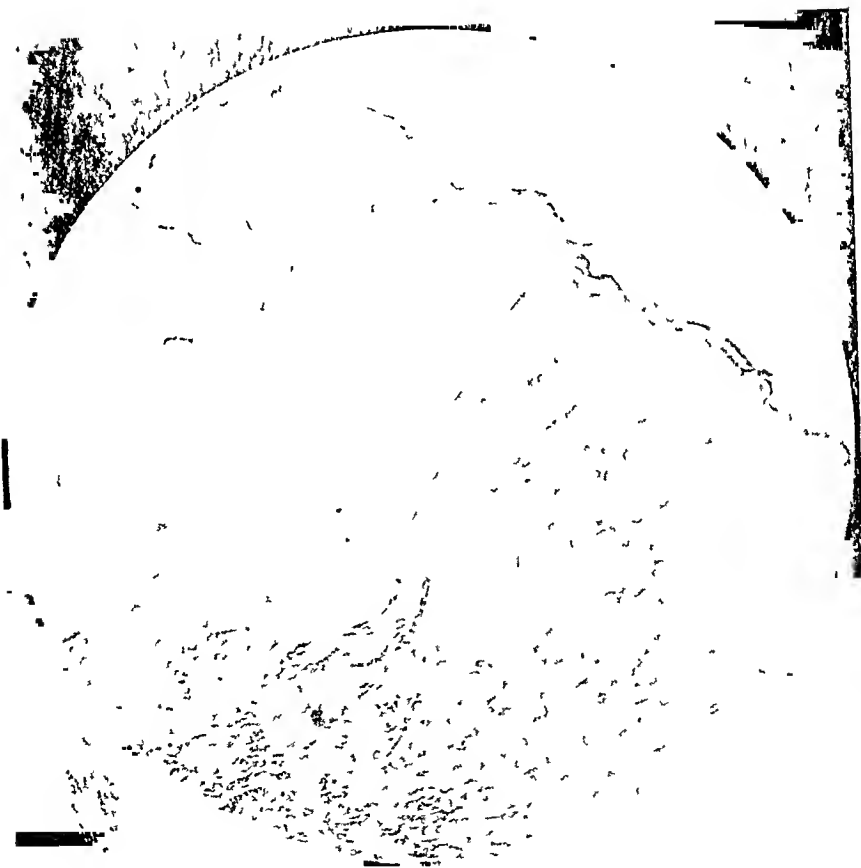


FIG. 2.—Microscopic section of papilloma of umbilicus.

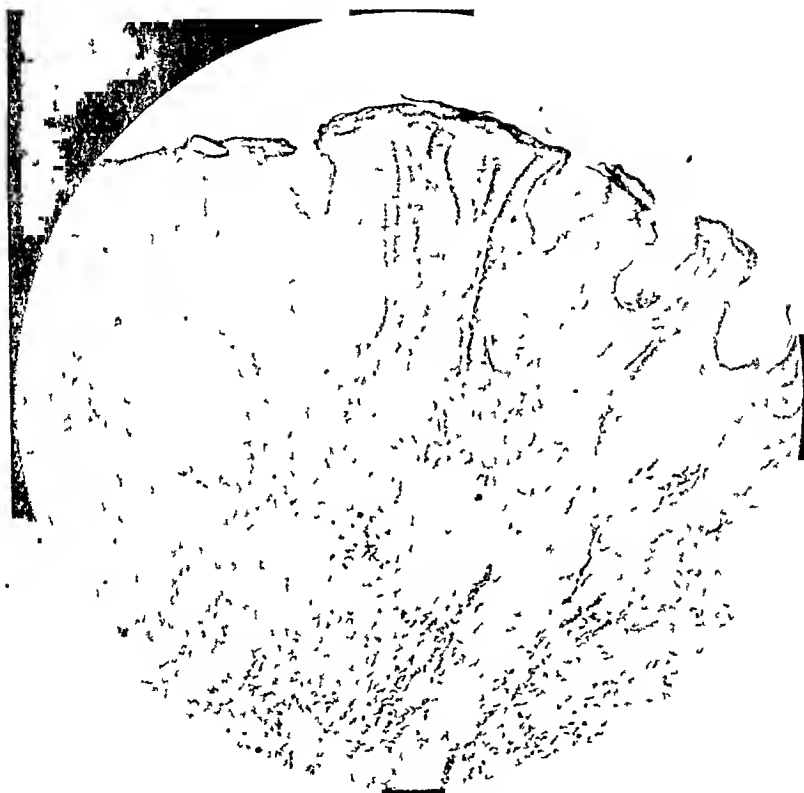


FIG. 3.—Microscopic section of papilloma of umbilicus.

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*Gross Pathology.*—The tissue consists of an elliptical piece of skin 4 by 8 cm., which surrounds a papillomatous growth 2 by 2 cm. The surface of the growth extended down along the umbilical tract and seemed to be fairly well encapsulated. It does not seem to invade the surrounding tissue.

*Microscopic Diagnosis.*—Papilloma.

*Microscopic Appearance* (Figs. 2 and 3).—A section of the tumor under the microscope shows papillæ flattened on top as if they had been pressed down from above. The entire surface is covered with a number of unbroken layers of squamous epithelium, the superficial layers of which are hornified, but still maintain their identity by showing, here and there, a nucleus. There is also an occasional epithelial pearl to be seen. The papillæ themselves are enlarged and swollen, and extend down into the underlying connective tissue, which is much thickened and shows a high inflammatory process. This inflammatory process has involved several of the papillæ, and cut off a part of them, so as to make them appear like nests of epithelial cells.

The papillæ themselves are infiltrated with a large number of small round cells between the epithelial cells, a great many of which are eosinophiles, while some are polymorphonuclears.

Cullen classifies these tumors as benign and in a foot-note, on page 351, in his recent work, "The Umbilicus and Its Diseases," he says, "In the ordinary umbilical papilloma the growth is caused by a proliferation of the stroma—the squamous epithelium covering the papillæ occupies merely a passive rôle."

When the microscopic sections of this tumor are studied—microphotographs of which are here presented—one cannot help but see that his conclusions may be right, as it appears the stroma plays a very important part, quantitatively, in the development of this tumor, and that the epithelial enlargement in this case may really be a so-called precancerous condition.

I wish here to acknowledge my indebtedness to Dr. Cullen, in the preparation of this paper, as I have drawn largely on his recent, and very complete, work on this subject, and at times have quoted him verbatim.

# THE HEALING OF GASTRO-INTESTINAL ANASTOMOSES

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IN 1905, while working out a method of aseptic intestinal anastomosis in Vienna, I took occasion to make a careful histological study of a series of gastro-enterostomies, which were performed during this series of experiments. The desirability of immediate publication of these observations was lessened by the appearance of Gould's<sup>2</sup> book, "Operations Upon the Intestines and Stomach," in which another series of preparations was pictured and described. Owing to brevity of Gould's account of the healing process, as well as a difference in the interpretation of some of its features, it has seemed desirable to publish an account of these observations.

The first published observations on the process of healing of gastro-enterostomies were made by Marchand<sup>3</sup> who pictures and describes a single specimen six days old. From the preparations studied by Gould,<sup>4</sup> the following conclusions were reached. After five days, the mucous membrane which has been injured during the operation sloughs and separates, leaving an ulcer with a floor covered by an exudate, at the edges of which one notes the beginning of regeneration of the mucosa from both the stomach and intestinal sides. This progresses so that the defect is completely covered by a low mucous membrane at the twenty-first day. In his specimens, he did not observe any regeneration of the muscularis mucosæ. A substitute for this layer of the intestine consists usually of connective tissue in which are found cells resembling smooth muscle in the later specimens. The muscle tunics, according to Gould, are held together by scar tissue arising from the intermuscular connective tissue which contracts and approximates the muscle ends so that the resulting scar may be scarcely recognizable by the naked eye.

Another series of specimens were studied by F. B. Murphy,<sup>5</sup> in which the anastomosis was made by the McGraw ligature. This investigator was interested in problems associated with the technic of the operation, especially in the time taken for the opening of the stoma by the ligature rather than in the details of the healing process. Three stages of healing anastomoses are pictured by Murphy, in which it is interesting to observe the close parallel between the repara-

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tive process in specimens obtained by the ligature and suture methods notwithstanding the great difference in the operative technic.

The experiments were performed upon dogs under ether anaesthesia; the anterior operation was done for the obvious reason that it possesses the same advantages in four-footed animals that posterior gastro-enterostomy does in human beings.

The specimens from which the illustrations for this paper were drawn were obtained from operations in which two tiers of interrupted silk sutures were employed to make the anastomosis. In course of the experiments, other methods of suturing were also used for comparison, like the Wölfler technic of an outer interrupted tier, a continuous seromuscular and an inner mucosal stitch. The first two suture lines were of Pagenstecher or black silk, while the inner was of chromicized catgut. Operations were also performed by the Mayo method of an outer interrupted silk and an inner continuous catgut suture. The healing process by these different suture methods is approximately the same; variations occurring in the specimens according to the degree of operative traumatism inflicted rather than depending upon the types of sutures employed, although there may be a slight delay in healing due to the presence of the mucosal stitch. There developed, however, in course of the work problems associated with the use of the non-absorbable suture materials which will be discussed in a later paper.

The experimental animals were allowed to live for increasing periods of time, when they were anaesthetized, the anastomosis inspected in a living state, whereupon the animals were killed and the preparation removed. Both the stomach and the intestine were washed quickly with running water and then distended while still alive with Zenker's fluid. Thereupon, they were placed in vessels filled with the fixing fluid. In this way, the tissue was instantaneously killed and fixed, and the shrinkage, usually accompanying the ordinary methods of fixation of hollow viscera, was prevented. Sections were then made from different portions of the preparations, from which the following account of the healing process is taken.

The first gross evidence of the process may even be observed before the termination of the operation in a slight fibrinoplastic exudate, which tends to glue the serous surfaces of the stomach and intestine together, an observation previously made by Halsted<sup>6</sup> and Mall<sup>7</sup> in their studies of the healing of intestinal wounds. This union is, of course, of the most delicate nature, but it is, nevertheless, sufficient to seal the edges of the openings between the sutures uniting



the two viscera. The next stage of the process lasts from 24 to 72 hours, and depends, apparently, in large part upon the location of the incision and the sutures with reference to the blood supply of the portions of the gastric and intestinal mucosa adjacent to the anastomosis. That is to say, if both of the flaps of mucous membrane after their section have a good blood supply, the healing process may take place in limited areas of anastomosis by what we are accustomed to call "first intention," namely, with a minimum of inflammatory

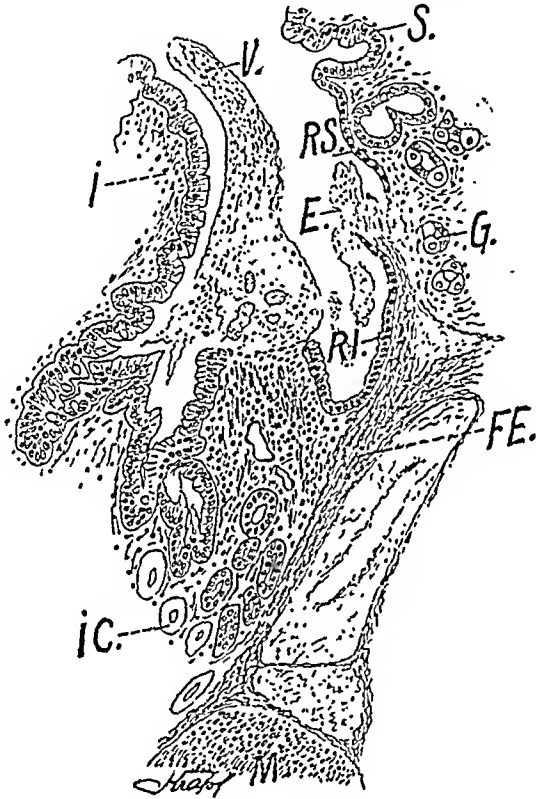


FIG. 1.—Section of the mucosa of a healing gastro-enterostomy twenty-four hours old. *I*, intestinal epithelium; *E*, fibrinoplasmic exudate; *IC*, intestinal crypts; *G*, gastric glands; *FE*, fibrinoplasmic exudate in the submucosa; *M*, cut end of the longitudinal layer of muscle of the intestine; *RI*, regenerating intestinal epithelium; *RS*, regenerating stomach epithelium; *V*, stroma of an injured villus.

reaction. If, on the other hand, there is an interference with the nutrition of the mucous membrane of the stomach or intestine adjacent to the opening by either the incision or the sutures, then the process of healing proper is preceded by an infiltration and partial necrosis of that portion of the mucosa which is deprived of its normal blood supply. The subsequent regeneration does not then occur until the line of demarcation is drawn between the injured and the healthy tissue. In general, we may say that the conditions of the operation seldom favor "per primam" healing even in parts of the anastomosis and never throughout its entire circumference.

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That these conditions should be exceptional follows from the researches of Mall<sup>8</sup> and Disse<sup>9</sup> upon the blood-vessels of the stomach and intestinal mucosa. According to these investigators, the arteries of the gastric mucosa and of the intestinal villi are practically end arteries, so that any interference with them leads either to an infarction or necrosis of the territory which they supply. As an evidence that this exceptional method of healing sometimes takes place, I may begin by describing one of my twenty-four-hour specimens before taking up consecutively the ordinary slower process, which forms the rule.

In this specimen (twenty-four hours, Fig. 1) the vessels had been cut so that there was practically no hemorrhage. Furthermore, the free ends of the muscular tunics of both viscera, freed from their tonus, had so contracted that the mucous membranes were brought nicely into apposition while the cut ends of the longitudinal and circular muscle layers of stomach and intestine were in consequence buried in the submucosa. There had been an immediate union of the serous surfaces by a slight fibrinoplastic exudate and only in the neighborhood of the stitch can one observe an infiltration of marked degree. At the time the animal was killed, the turned-in serous and muscular tunics gripped by the sutures are now joined by a thin layer of fibrin containing a few leucocytes which passes up as far as the incision in the mucosa. The muscularis mucosæ on both sides is somewhat retracted, but the longitudinal musculature of the intestine (Fig. 1, *M*) aids in filling the gap between the two cut ends of this thin sheet of muscle. This relationship is important as we shall find that the muscularis mucosæ is often partially regenerated from or substituted for by muscle derived from this source. At the point of incision in the mucosa there is a small plug of fibrin (Fig. 1, *E*) projecting for a short distance between the cut edges of the gastric and intestinal mucosa, while in the immediate neighborhood of the wound a few intestinal crypts and gastric glands show signs of degeneration. Notwithstanding, the regeneration of both stomach and intestinal epithelium has already begun. On the stomach side, the epithelium (Fig. 1, *RS*) from one of the adjacent gastric glands has undergone proliferation and extends as far as the tuft of fibrin, which projects from the submucosa at this point. This regenerative process may start from the epithelium at the mouths of the gastric glands or from the more highly organized epithelium forming the tubules, although in the latter case it ordinarily returns to its original undifferentiated embryonic form before the reparative process is inaugurated. From the development of the stomach mucosa, this is

what we might expect as the glands are formed by downgrowths of the epithelium which lines the simple digestive tube. In this reparative process, the high cylindrical character of the epithelium is lost and it becomes first cubical; then, as one proceeds to the edge where the youngest cells are formed, they become flattened to thin plates of protoplasm with oval flattened nuclei (Fig. 1, *RS*). In the few degenerating glands on the stomach side (Fig. 1, *G*), the chief cells are the first to lose their adult characteristics and undergo a hyaline degeneration, while the parietal cells hold their form for a longer period and appear much more resistant.

On the intestinal side of the anastomosis, a partly injured villus (Fig. 1, *V*) with an infarction of the tip is seen and the crypts belonging to it are slightly degenerated. From the tip of the villus, the epithelium has disappeared and the meshes of its stroma are filled with extravasated blood. Just above the base is a sharp line of demarcation, indicating that the region below is well nourished and will live.

From the fundus of the crypt at the side of the injured villus, the epithelium has, like that of the stomach, returned to its embryonic form (Fig. 1, *RI*) and is growing up on the opposite side of the sulcus formed by the projecting bit of fibrin (Fig. 1, *E*). Here it has already partly clothed the intestinal side of the unorganized fibrin with a layer of young flattened epithelium. At this period, there is no evidence that the presence of the acid gastric juice has had either any digestive or inhibitory action on the regeneration of the intestinal epithelium. The cells respond immediately to the injury and endeavor to clothe the denuded area at once, provided that they still retain their vitality. The future of such a portion of the anastomosis as is shown in this specimen can readily be imagined. In forty-eight hours or three days the surface of repair of the mucosa would be finished and there would only remain the further organization of the fibrinous exudate and the regeneration of the muscularis mucosæ to make the union as complete as is possible in such region. About the sutures, which are not absorbable, there would always naturally be such a reaction as is usually found around a foreign body, while at the point of junction between two dissimilar epithelia, a few bizarre epithelial cells would be seen, indicating the place where the two types of mucous membrane meet.

In contradistinction to the very unusual process outlined above, the ordinary reaction, at this stage (24 hours) is much more violent and depends, apparently, upon the injury to the circulation of the mucosa included between the inner tier of sutures. The anastomosis of both arteries and veins is rich in the deeper layers of the intestine

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and stomach and, consequently, readjustments are readily made. In the mucosa, on the other hand, this is not the case, moreover, it is this region of the operative terrain which has to bear the brunt of further injury in the passage of secretions and food from the stomach to the intestines through the new channel formed by the anastomosis. My experimental animals were given milk the day after operation and soft food on the third day, as I desired to see if the healing process would be materially retarded by the ordinary functions of the stomach.

In an average specimen of the anastomosis such as is shown in

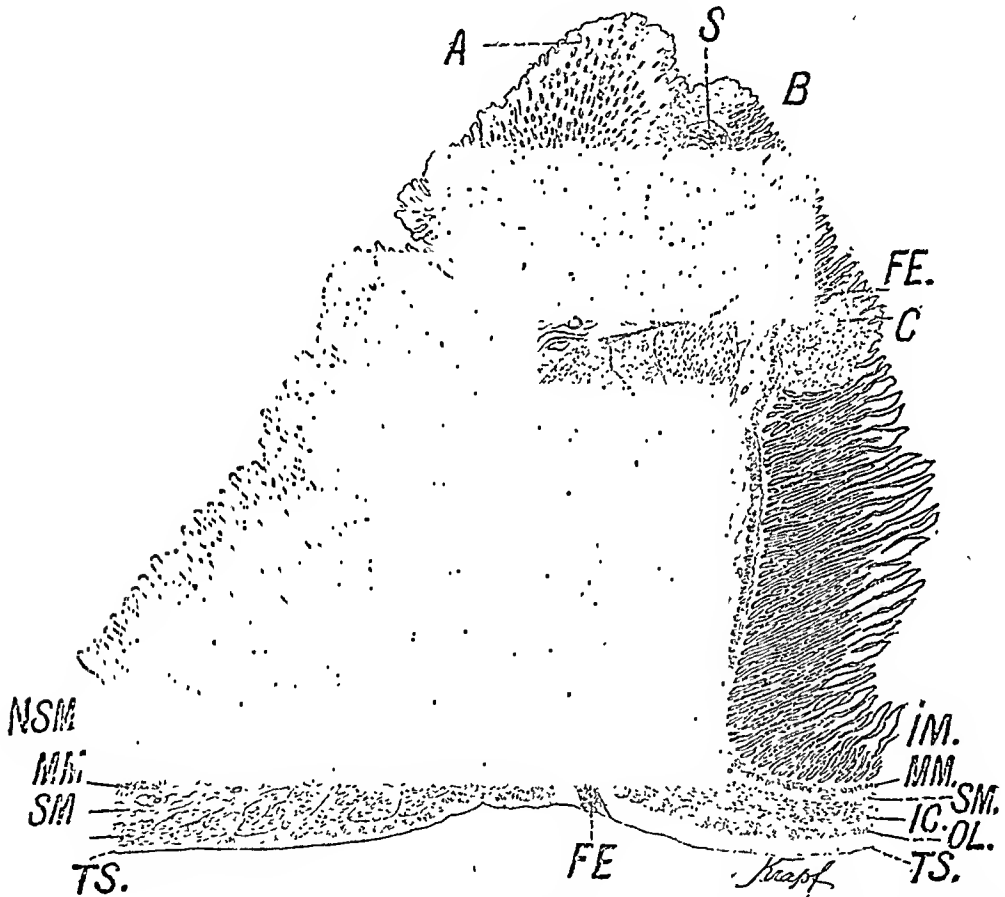


FIG. 2.—Section of gastro-enterostomy twenty-four hours old. NSM, gastric mucosa; IM, intestinal mucosa; MM, muscularis mucosae; SM, submucosa; IC, inner circular layer; OL, outer longitudinal layer; TS, tunica serosa; FE, fibrinoplastic exudate; S, stitch; A, degenerating gastric mucosa; B, degenerating intestinal mucosa; C, needle wound in the mucosa.

Fig. 2, the serous membranes are already adherent by a fibrinous exudate, containing numerous leucocytes and small round cells (Fig. 2, FE). The condition of the mucosa is normal a short distance from the point where the two types join. In the immediate neighborhood of the incision its condition must be looked upon as distinctly regressive, as the line of demarcation between that which is to persist and that which is to become necrotic has not yet become clear. This destructive process always precedes the inauguration of the regenera-

tive process. In this region at this stage, the traumatized mucous membrane of both stomach (Fig. 2, *A*) and the intestine is being partly digested by the gastric juice, as is shown by the pallor of the cells in the portion exposed to its action. The deeper layers are markedly infiltrated by leucocytes. In the degenerating fundus of the gastric glands, the chief cells are paler and have a more hyaline appearance than the parietal cells, which, though not by any means normal, seem more resistant than the chief cells. Their nuclei are darker and their cytoplasm retains its characteristic staining reaction longer than the other cells of the gastric glands. To the right of the line of section is a zone of the intestine (Fig. 2, *C*) that has been perforated by the needle and suture. Here, the muscularis mucosæ is ruptured and the intestinal mucosa is degenerating. At this point there is an intense reaction and infiltration by leucocytes and small round cells mixed with strands of fibrin. The muscularis mucosæ on both sides of the incision in the mucosa is retracted, leaving a zone of the submucosa unprotected. In consequence the cut end of the intestinal musculature rests directly against the degenerating mucosa.

In these average cases, the next few days shows a continuation of regressive process until the degeneration is complete and the organization of the exudate upon the necrotic mass begins. At the same time, the demarcation of the injured tissue is patent and, from the mucosa on either side of the exudate, regeneration begins. This stage is well shown in a seven-day specimen (Fig. 3). At this time the regressive changes have practically ceased and repair is fairly under way.

The serous membranes are now firmly united by the organization of the fibrinous exudate, the cells of which pass in between the bundles of longitudinal muscle fibres. On either side of the wound, the mucous membranes are sharply differentiated and the necrosis of the poorly nourished portion is not only complete, but the regeneration of the portion which was injured but not destroyed has been practically accomplished. In this region of minimum reaction, the stroma is clothed with a new epithelium somewhat younger and lower than that of the normal stomach, while the injured bases of the adjacent villi on the intestinal side are also covered with an epithelial layer, less differentiated in character than that of the normal intestine. This region is shown in the drawing (Fig. 3) by the thinning of the epithelium and its loss of villi. The exudate over the site of the wound in the mucosa is partly organized and the healing of the defect is progressing both from the gastric and the intestinal sides of the anastomosis. The villi and the gastric glands that lost their epithelium have both received a new coat, while the epithelium of the

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mouths of the gastric glands, on the one hand, and from the epithelium of Lieberkühn's crypts, on the other, cells have grown out to cover the partly organized exudate. From the stomach side, the epithelium rapidly flattens as it passes down into the invagination (Figs. 3 and 4, *RS*) between the mucosa and mounts up on the exudate. Here it is in the form of flat cells that bear absolutely no resemblance to the high columnar cells which gave rise to them.

As the new formed layer approaches the edge of the organized

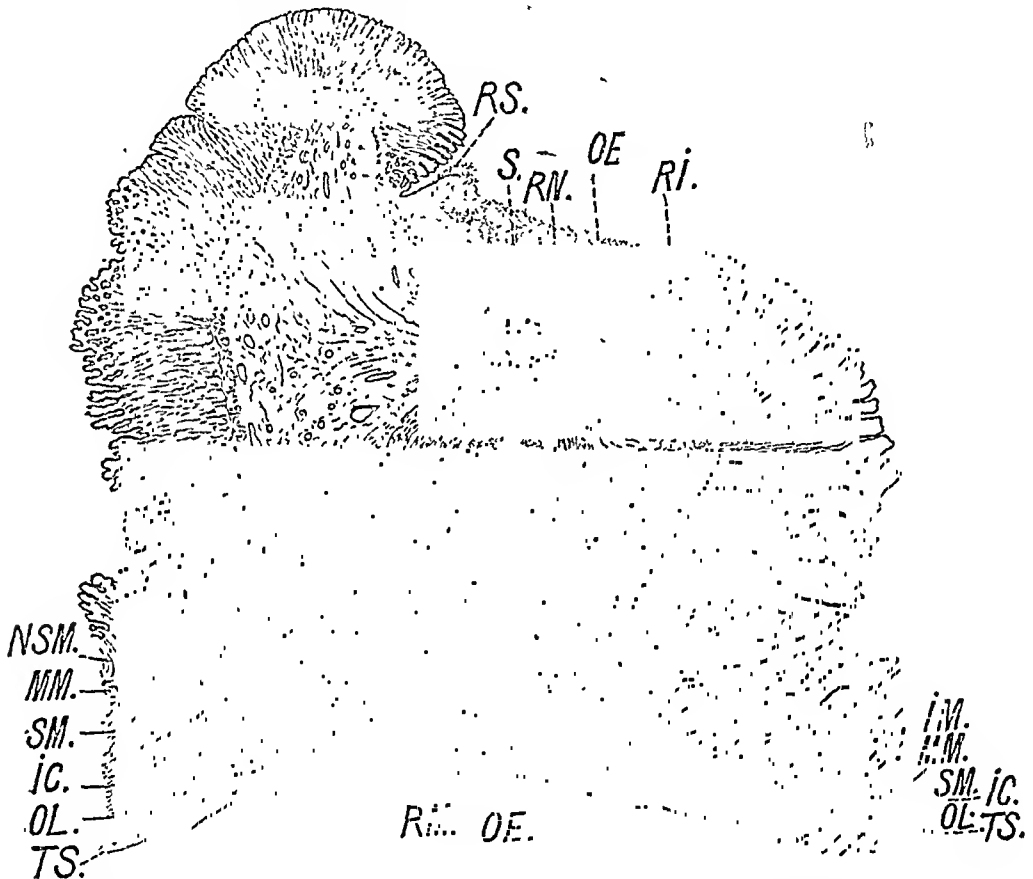


FIG. 3.—Section of a gastro-enterostomy seven days old. *RS*, regenerating gastric mucosa; *RI*, regenerating intestinal epithelium; *OE*, organizing exudate; *S*, stitch; *RN*, regenerating muscularis mucosae; *NSM*, normal gastric mucosa; *IM*, normal intestinal mucosa; *MM*, muscularis mucosae; *SM*, submucosa; *IC*, inner circular layer; *OL*, outer longitudinal layer; *TS*, tunica serosa; *RM*, regenerating longitudinal musculature.

exudate, it penetrates its substance instead of growing up on its surface. This overlapping of the exudate (Fig. 4, *A*) possibly serves to protect the youngest cells from the gastric juice. There are a number of karyokinetic figures in the epithelium from the mouths of the gastric glands as well as in the embryonic glands in the neighborhood of the sulcus that separates the exudate from the regenerating portion of the mucous membrane (Fig. 4, *RS*). In this zone, the glands have returned to their embryonic form, that is to say, they have no differentiated cells, but are lined with a layer of low columnar or cubical cells. There is no distinction between chief and parietal cells.

On the intestinal side, there is, as on the gastric side, a zone where the mucosa has been injured but not destroyed. This region is characterized chiefly by a loss of the villi (Figs. 3 and 5, *RI*) and the presence of a series of crypts that have returned to their embryonic form, that is to say, crypts that show little or no differentiation in

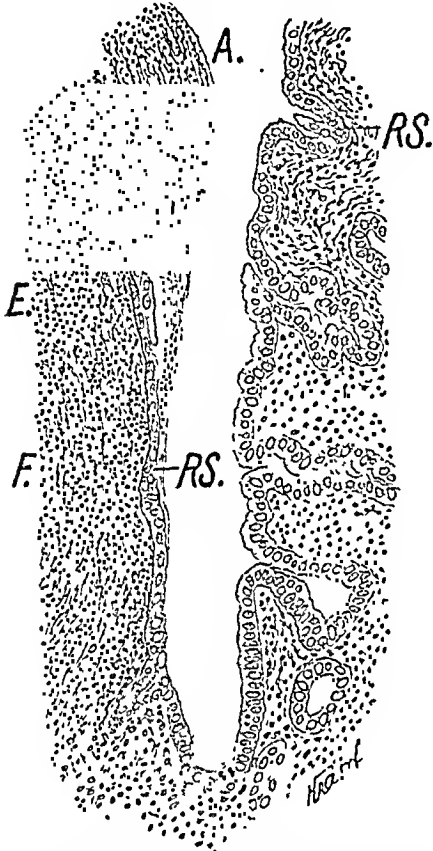


FIG. 4.—Section of the zone between the regenerating mucosa of the stomach and the organizing exudate. Same preparation as Fig. 3. *RS*, regenerating gastric epithelium; *A*, exudate overlapping the young epithelium; *E*, organizing exudate.

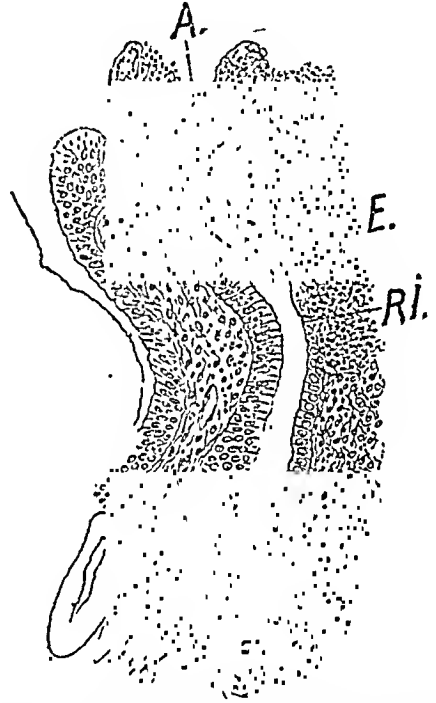


FIG. 5.—Section of the zone between the regenerating intestinal epithelium and the organizing exudate. Same preparation as Fig. 3. *E*, organizing exudate; *RI*, regenerating intestinal epithelium.

the epithelium that clothes them. They are lined by a low columnar epithelium showing very few or no goblet cells.

At some points, the first stages of the differentiation of the goblet cells from the embryonic form of epithelium may be made out. Karyokinetic figures are often seen in the epithelium of these young crypts. As the zone of maximum injury in the neighborhood of the wound is approached, the columnar form of epithelium rapidly flattens and as it passes over the sulcus between the healing mucosa and up on the exudate (Fig. 5, *RI*), like that of the stomach, it becomes extremely flat. It penetrates the substance of the exudate (Fig. 5, *A*)

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and gives, in sections, the appearance of being overhung by a flap of the exudate mass. Here the cells are of irregular flattened form with fairly large vesicular nuclei (Fig. 5).

The exudate is now composed of a mass of young connective tissue cells containing a great deal of detritus and cellular debris. There is naturally also a quantity of round cells and leucocytes in the mass as well as numerous young blood-vessels. Here and there one sees pale cells with large round nuclei and a considerable amount of protoplasm, which stains densely with acid dyes. These appear to be the shadows of epithelial cells originating from necrotic glands of the stomach and intestine. Either they have not entirely lost their vitality, or are regenerating in the rapidly organizing exudate, from a few rests of the old glands.

Immediately under the exudate there is a group of young muscle fibres extending from the region of the Muscularis mucosæ in the intestine to the cut end of the same layer in the stomach. This is probably a case of precocious regeneration, for I possess older stages where the muscularis mucosæ is not being so completely restored. However, it also appears probable from my specimens that, in certain instances, muscle cells may be derived from the cut ends of the muscle tunics of the intestine or stomach, which aid in the reestablishment of the muscularis mucosæ. At the lower angle of the enfolded serosa there are already distinct evidences of the regeneration of the muscular tunics over the gap between the stomach and intestine (Fig. 3, *RM*) now occupied by young fibrous tissue. These young muscle cells appear to spring principally from the outer oblique fibres of the stomach. This cannot be looked upon, however, as a constant accompaniment of the healing process, as I possess later stages where the healing is complete without this gap being bridged by muscle fibres at all. But while the process does not invariably occur about the entire anastomosis, it may be present in one portion and not in another. It appears probable that this regeneration may be associated with a tearing of the outer muscular coats of both stomach and intestine by the outer row of sutures. From the broken ends of the muscle bundles the new regenerating elements are formed. It is possible that the direction of the muscle pull during peristalsis of anastomosed viscera may be an influencing factor. This contraction with partial fixation of the muscle by sutures may aid in liberating the muscle bundles so that the regeneration can take place on the free end.

*Fourteen Days.*—At this stage there is now little evidence of the inflammatory reaction save in the immediate neighborhood of the



stitches (Fig. 6, *S*). The break in the mucosa has healed over so that the passage between the lumina of stomach and intestine is now lined by a continuous layer of mucous membrane (Figs. 6 and 7). In the zone of minor injury, where the mucosa was not entirely destroyed, the repair process is well advanced, for, on the stomach side, one sees a group of young gastric glands developing apparently along embryological lines (Fig. 6, *RS*). By this is meant a group of glands now differentiated into mouth and crypt or tubule, but young in the sense that they have principally chief cells for their lining, while showing only here and there parietal cells interpolated between the chief cells in the position where they differentiate from the indifferent embryonic cells that line the young glands.

On the intestinal side of the wound the tissue in the zone of minor injury (Fig. 6, *RI*) consists of a series of embryonic crypts surmounted by slight projections suggestive of young villi. In this region some of the crypts contain goblet cells, but they are by no means as numerous as in the healthy mucosa.

In the regenerated portion of the mucosa over the zone of maximum injury there are infoldings of the epithelium from young crypts on the intestinal side and gland on the stomach side. The new membrane has, however, by no means reached the normal thickness. On the stomach side, the cells (Fig. 7, *RS*) are high like those lining the mouth pieces of the gastric glands, while those on the intestinal side (Fig. 7, *RI*) contain a much larger percentage of goblet cells than is the case in my other and even much older preparation.

The line of demarcation between the two types of epithelium is absolutely sharp, as differentiation is possible to the point where the last stomach cell ends and the first intestinal cell begins. In this particular case, owing to the presence of the goblet cells, the darker staining gastric mucosa affords a particularly sharp contrast to the lighter colored intestinal epithelium. Here, too, are missing the few abnormally formed cells which usually occur on either side of the meeting point of the regenerated epithelia (Fig. 11, *A*). The reaction has disappeared from the region of the mucosa. The muscularis mucosæ has partially regenerated from each side (Fig. 6, *RN*) and the intervening gap is filled in by a portion of the muscle from the circular and longitudinal layers of the intestine (Fig. 6). The organized exudate observed between the longitudinal muscle of both organs in the preceding stage has been transformed into connective tissue except in the neighborhood of the sutures, where a dense infiltration still exists. Here, in the meshes of the silk fibres, are found young connective tissue cells and numerous leucocytes. Nearby

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foreign body giant cells may be seen. These are also to be seen in the interspaces between the muscle bundles at some distance from sutures.

*Twenty-three Days.*—At this stage the repair is so far advanced

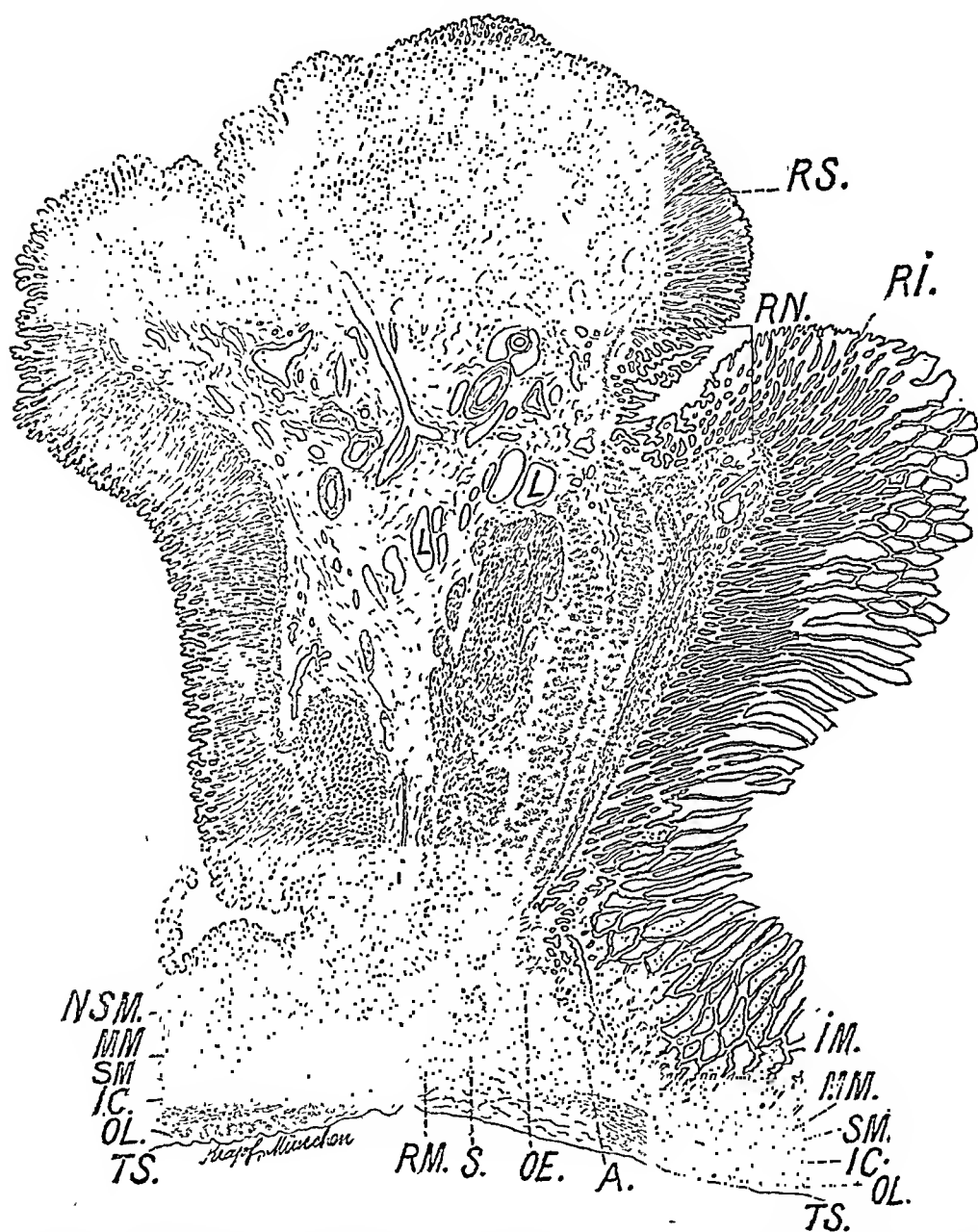


FIG. 6.—Section of gastro-entrostomy fourteen days old. NSM, normal gastric mucosa; IM, intestinal mucosa; MM, muscularis mucosæ; SM, submucosa; IC, inner circular layer of muscle; OL, outer longitudinal muscular layer; TS, tunica serosa; RS, regenerating gastric mucosa; RI, regenerating intestinal mucosa; RN, regenerating muscularis mucosæ; RM, regenerating muscular tunic; S, stitch; OE, organized exudate; A, ingrowth of Lieberkühn's crypts following injury to the muscularis mucosæ.

that the apposition of normally different types of epithelium may, with the presence of the stitches, be the only thing which gives obvious evidence of the anastomosis. The study of the preparation with the higher powers shows, however, that numerous abnormalities are present. On the whole, the condition of the anastomosis at this stage

naturally depends on the amount of injury done to the tissue at the point where the operation was performed. If the injury was minimum, both stomach and intestinal mucosa may be practically normal within a short distance of the point of union, where a group of bizarre cells occur in both types of epithelium. If the injury is excessive there, there is a zone where mucosa is abnormal, that is to say, where



FIG. 7.—Zone of junction of the gastric and intestinal epithelium from the fourteen-day preparation shown in Fig. 6. *RI*, regenerating intestinal epithelium; *RS*, regenerating gastric epithelium.

it persists in its more embryonic form until the slower process of differentiation takes place. Naturally, there are, in most anastomoses, points where both conditions obtain, as the mucosa may suffer greater injury at one point than at another. In consequence, the healing is often more advanced in some regions than in others. In one of my preparations, at this stage, the healing may be said to be complete. The continuity of the mucosa is reestablished and well formed crypts and villi are found next to practically normal gastric glands.

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The muscularis mucosæ has regenerated over the gap, partly from the stomach side, partly from the intestinal side, and partly by the contribution of a few fibres from the inner circular layer of muscle of the intestine. The infolded muscular coats of both stomach and intestine have grown firmly together by means of the connective tissue derived from the fibrinoplastic exudate, which sealed the two viscera at the time of the operation. About the suture, there is a mass of fibrous tissue containing some foreign body giant cells.

*Thirty and Forty Days.*—In these specimens the healing of the submucosa and muscular tunics is usually complete or well advanced, although the degree to which the tunica muscularis is restored depends both upon the position of the section and the condition of the involved layers. In the thirty-day specimen shown in Fig. 8, the continuity of the infolded longitudinal muscle has been broken by the stitch and, in consequence, the circular muscle is well regenerated beneath it. Likewise a few bundles from the outer longitudinal coats have begun to bridge the gaps filled by the organized fibrous tissues which join the tunics in the younger layers.

The muscularis mucosæ has regenerated from both sides but is very thin. It is, however, strengthened by fibres derived from the cut end of the outer longitudinal muscular tunic of the intestine, making complete the muscular foundation upon which the mucosa rests. At the site of the incision in the mucosæ, there is still an irregular fold as these layers have not regenerated to their usual thickness.

On the intestinal side the crypts are practically normal except in the absence of the usual numbers of the goblet cells. The villi that have been destroyed appear to be regenerating (Fig. 8), as there are short irregular elevations from the general level of the mucous membrane containing the stroma of villi and covered by an epithelium slightly lower than that of the adjacent normal structures. On the stomach side there are numerous young glands already well differentiated into mouthpiece and tubule, but still lacking the requisite number of parietal cells to give them the typical character of the adult gastric glands. Here and there, however, they may be seen developing from the epithelium lining the tubules. They appear as cells with a slightly greater acidophilic reaction to their cytoplasm, which in the subsequent development of the tubule became shunted off to the side, where they take up their final normal peripheral position in the gland.

*Fifty-five Days.*—In this stage as in the earlier preparations the healing is complete but the entire restoration of the mucous membranes depends to a great extent upon the degree of the injury. The regeneration in my preparations of this period appears in places to have

been retarded by the necessity of an extensive repair. So far as the function of the anastomosis is concerned, the entire opening between the two viscera has long been clothed by a mucous membrane of normal thickness. The preparation shows the complete transformation of all the exudate into connective tissue except in the region of the stitches (Fig. 9, *S*) where numerous round cells and a few foreign body giant cells occur in the framework. The gap between the two infolded layers of muscle in this preparation is not bridged by any newly formed fibres, but the connective tissue keeps them effectually together.

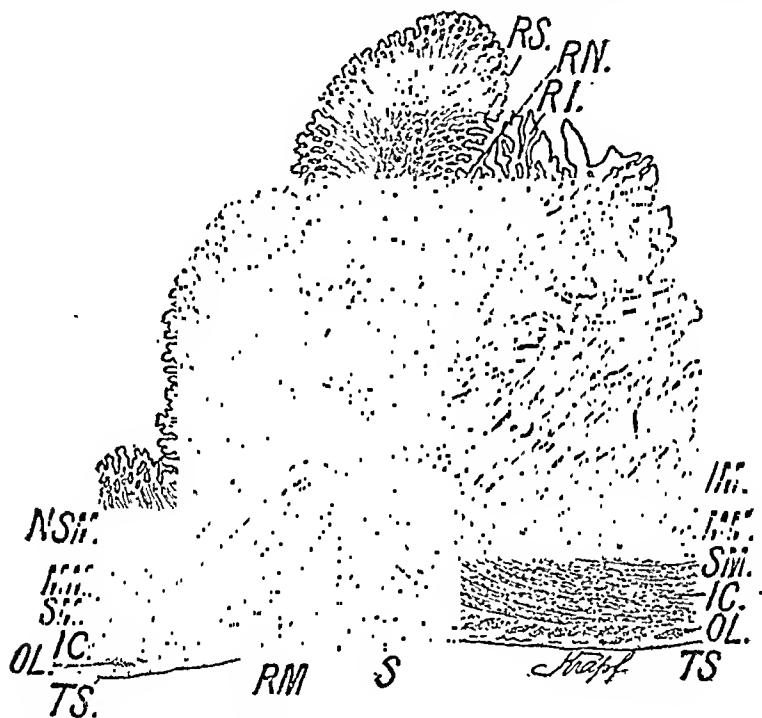


FIG. 8.—Section of gastro-enterostomy thirty days old. *RS*, regenerating gastric mucosa; *RI*, regenerating intestinal mucosa; *RN*, regenerating muscularis mucosa; *NSM*, normal gastric mucosa.

The muscularis mucosæ likewise (Fig. 9, *RN*) does not form a complete layer under the mucosa but is partly compensated for by bundles of muscle derived from the circular layer of the stomach. The presence of a stitch (Fig. 9, *S*) at this point has apparently prevented the regeneration of this muscular sheet, but it also provided a firm enough floor to prevent the ingrowth of the glands and crypts into the region of the submucosa. In the mucosa there is a practical restoration of the original thickness of the mucous membrane except at the site of the wound, where an irregular depression occurs.

This is probably the result of the presence of the stitch, as my other sections of this anastomosis show the normal thickness of the mucosa in this region. But, notwithstanding, on the intestinal side

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a number of villi remain to be regenerated, while on the stomach side of the wound glands are not entirely differentiated as is shown by the absence of parietal cells in many of them. That the regeneration is in progress is shown by the presence of karyokinetic figures and by the fact that from the site of the wound in the mucosa, where the glands are youngest, they take on a progressively older character as one proceeds to the zone of the uninjured mucosa. From glands without parietal cells, those partially provided with them are at first encountered while further out they become completely normal.

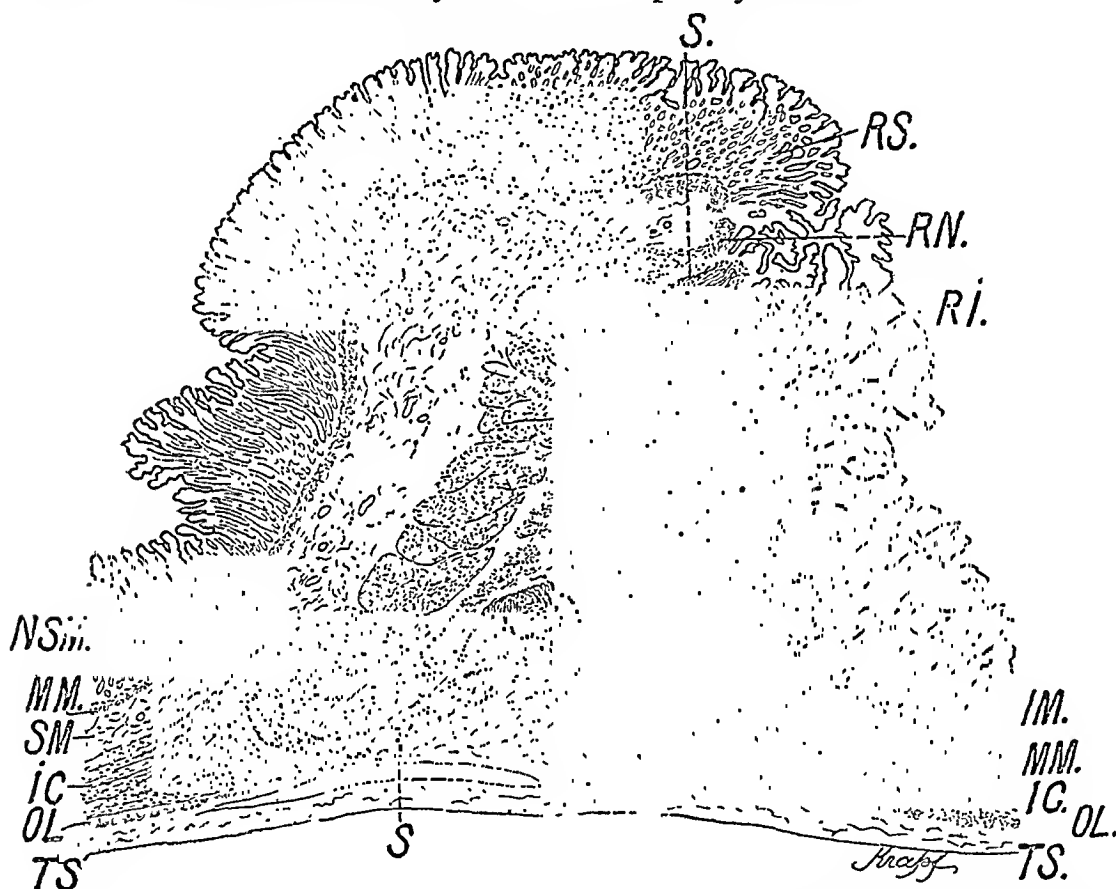


FIG. 9.—Section of a gastro-enterostomy fifty-five days old. RS, regenerating gastric mucosa ; RI, regenerating intestinal mucosa; RN, regenerating muscularis mucosæ; S, stitch; NSM, normal gastric mucosa; IM, intestinal mucosa; MM, muscularis mucosæ; SM, submucosa; IC, inner circular muscular layer; OL, outer longitudinal layer; TS, tunica serosa.

The means by which this restoration of the gastric glands takes place occurs as follows: The young elements are formed from rests of glands in this zone of minimum injury, and from the invagination of the epithelium that grows out on the exudate; subsequently they differentiate into mouthpiece and tubule.

From the low columnar epithelium that lines them, cells appear that show a distinct acidophilic reaction in their cytoplasm. These begin to grow larger but they still maintain, however, their position in the same plane as the other cells of the gland (Fig. 10, P). As the

differentiation proceeds, they increase in size and are gradually pushed back to the side of the tubule where they take up their final adult position. This method of differentiation, of course, is similar to that by which the parietal cells are produced in the embryo.

Figure 11 shows the segment of the healed mucosa fifty-five days old just over the site of the incision in the two mucous layers. On the intestinal side, the crypts (Fig. 11, C) are now clothed with a columnar epithelium in which the differentiation of the goblet cells has to a great extent taken place. Here and there in the fundus and the sides of the crypts, karyokinetic figures are found. Projections from the surface of the mucosa indicate the formation of the new villi.

On the stomach side, the gastric glands are still young and show only the differentiation into mouthpiece and tubule. In the glands

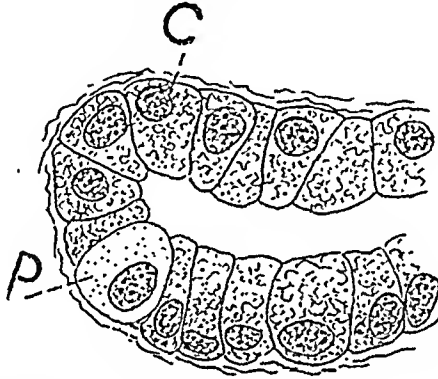


FIG. 10.—Regenerating gastric gland showing the formation of the parietal cells. From preparation shown in Fig. 9. C, chief cells; P, parietal cells.

as well as on the surface of the mucosa, karyokinetic figures indicate that the regenerative process is not yet complete. The cells of the gastric mucosa are all columnar in form, as parietal cells have not yet developed in the immediate neighborhood of the incision. At the point of junction of the two types of epithelium (Fig. 11, A), there are on both sides a few abnormally shaped cells. This condition is practically constant as long as the two forms of epithelium remain in contact.

#### SUMMARY

(1) The healing of gastro-enterostomies may, in parts of the anastomosis, take place by what we are accustomed to call "first intention," that is to say with a minimum of inflammatory reaction. This occurs when there has been only a slight interference with the circulation of the gastric and intestinal mucosæ. In these cases there is a prompt adhesion of the infolded serous surfaces of the two viscera by a slight fibrinoplastic exudate which also extends along the entire line of incision. The regeneration of the mucosa is well advanced in 24 hours and the defect in the mucosa may be covered

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in forty-eight or seventy-two hours. Nothing remains but the organization of the exudate to complete the healing. In such instances a portion of the anastomosis may be completely repaired in 5 or 14 days.

(2) The more usual and slower method of healing occurs when there has been more or less interference with the circulation of the

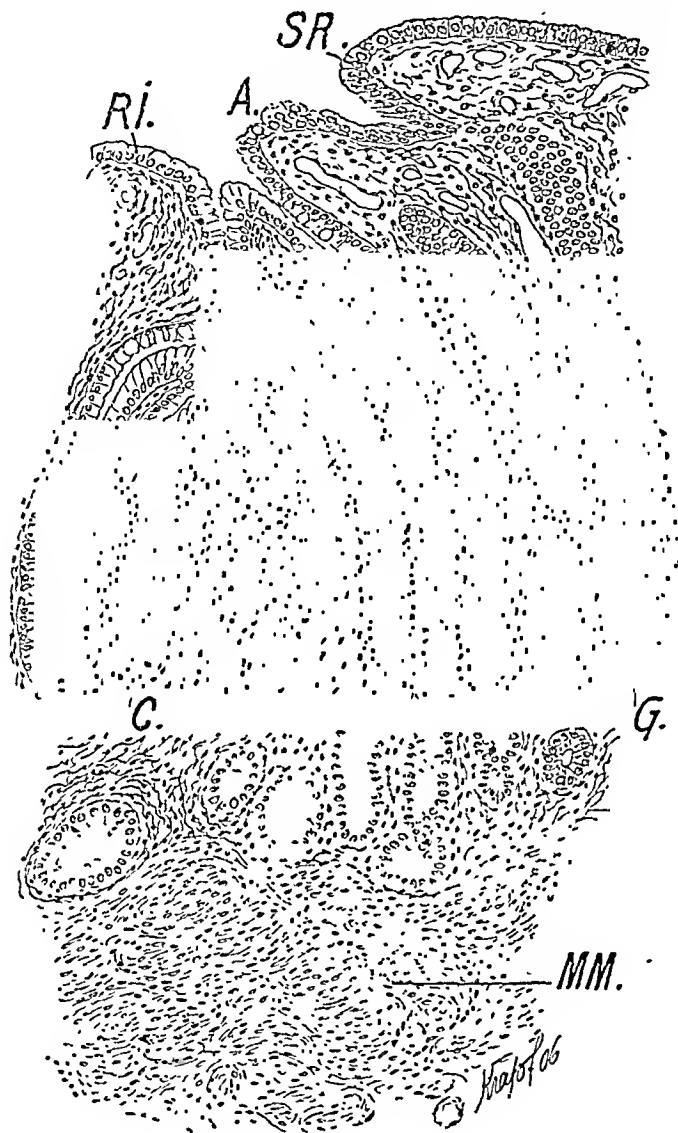


FIG. 11.—Meeting point of the gastric and intestinal epithelium in gastro-enterostomy fifty-five days old. *A*, abnormal cells at the point where the two types of epithelia meet; *RI*, regenerating intestinal epithelium; *SR*, regenerating gastric epithelium; *C*, crypt of Lieberkühn; *G*, young gastric gland; *MM*, new muscularis mucosae formed from the circular muscle of the stomach.

mucous membrane of the stomach and intestine. In these instances there is also an immediate union of the serous surfaces, which is accompanied by an exudate along the entire line of incision. A period of destruction now supervenes, involving those portions of the mucosa which have had their circulation injured or destroyed. This lasts from three to seven days, depending upon the extent of the injury. In the meantime the organization of the exudate has been progressing.



As soon as the destruction of the poorly nourished parts is complete, the period of restoration is inaugurated. This consists in repair of the injured mucosa and regeneration of the mucous membrane over the exudate forming the defect between the stomach and intestine. This is usually complete in 14 days. At the same time, the regeneration of the muscularis mucosæ and of the tunica muscularis is in progress.

(3) The regeneration of the intestinal mucosa takes place from the crypts which, in the neighborhood of the exudate, have returned to their embryonic form. From these crypts the epithelium flattens as it passes up on to the exudate, where it often penetrates its substance and forms a single layer of squamous cells. From this layer young crypts extend down into the organizing exudate and there produce new growing centres. The young villi appear as slight elevations from the general level of the mucosa and are gradually restored to their normal form. In the regenerative process the young crypts are, in the main, productive of the new elements, as nine-tenths of the karyokinetic figures occur in them. I have found, however, mitoses in the epithelium over the young villi, but they occur with relative rarity. After the restoration of the epithelium is complete the differentiation into the typical goblet cells and regular columnar cells takes place.

(4) The regeneration of the gastric mucosa generally begins from the less differentiated epithelium about the mouths of the gastric glands or from tubules that have returned to their embryonic form. As in the intestine, the new formed epithelium flattens as it passes up on the exudate, which it often penetrates as the extremity is reached. From this sheet of epithelium, new tubules are produced by invaginating into the substance of the exudate, which have the characters of embryonic glands. They are lined with an undifferentiated epithelium. As the preparation increases in age, cells appear in these young glands having a more or less strong acidophilic reaction to their cytoplasm. These increase in size and are finally pushed off to the side of the tubule and represent the young parietal cells. The remainder form the chief cells of the finished gland.

(5) The muscularis mucosæ begins to regenerate about the second week. It may be repaired from its cut ends or may be, in part, compensated for by means of muscle tissue derived from the severed ends of the tunica muscularis of either the intestine or the stomach. Tearing of this layer or failure of the layer to regenerate allows the crypts of the intestine to grow into the submucosa. At times these growths also occur at the site of the incision and penetrate for some distance into the submucosa and muscularis.

(6) At times the tunica muscularis does not regenerate at all, the infolded muscular layers being held together by new formed connective tissue. In other instances there is considerable regeneration of the muscular layers. This seems to occur when the muscle bundles have been torn or the stitches are so placed that the pull of the muscle during the peristalsis tends to free some of the bundles, from the ends of which the regeneration can take place.

(7) After the gastro-enterostomy there is no modification of the intestinal epithelium. The cells appear perfectly normal. Furthermore, the intestine heals normally in the presence of the gastric juice. This may be due to the fact that the portion of the intestine between the lateral anastomosis and the opening of the stomach may produce enough succus entericus to neutralize the gastric juice in the neighborhood of the wound or more probably antiferments are present in sufficient quantities in the intestinal epithelium to prevent the digestion of this portion of the mucous membrane. Inasmuch as there is no tendency for the submucosal or muscular tunics to undergo digestion during the healing process, they are likewise undoubtedly supplied with antiferments against the gastric juice, although they are protected in a certain sense very shortly after the injury by the appearance of the exudate between the severed edges of the mucosa of the stomach and intestine.

(8) The clinical bearing of these studies emphasizes the fact that it is well for us to know not only the reaction of the stomach and intestine to the operative traumatism inflicted in performing a gastro-enterostomy but also the reparative process through which the organs pass during the period of healing. One should remember that the new formed anastomosis is the site of a healing ulcerated surface for a period of fourteen days and that, for the first five or seven days, the process is largely destructive, at least so far as the mucosa is concerned. Sight of this fact ought not to be lost in feeding these cases for the first two weeks, during which period the diet should be as light as is compatible with the maintenance of the strength of the patient.

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# TRAUMATIC EXTRAPERITONEAL RUPTURE OF THE BLADDER WITH FRACTURE OF THE PELVIS

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AN interesting article on this subject appeared in the July issue of *Surgery, Gynecology and Obstetrics*, by E. P. Quain, M.D. He collected from the literature and reported 127 cases, including 1 of his own. They were spread over a period of nearly a century. Of these, 32 were reported in this country, the remainder abroad.

He showed the total mortality to be 74 per cent. Of 83 cases reported before the year 1890, the mortality was 86.7 per cent. Of 44 cases subsequent to the year 1890, the mortality was 48 per cent. From 1905, out of 21 cases, 8 died, a mortality of 38 per cent.

To the above list of cases I wish to add one upon which I operated, October 24, 1915.

The history of the case is as follows: Mrs. W., thirty-three years old, was driving her touring car over a road that had been recently oiled. Her young four-year-old son sat beside her, on the front seat, while her mother, father and sister occupied the rear one. In attempting to steer out for an approaching machine, her car skidded to the right, and when the off-wheels struck the dry dirt, the momentum carried the car over on its right side. All were thrown clear of the machine except Mrs. W. The side of the tonneau came over on to the small of her back, pinning her face down to the ground.

Through the efforts of her father, in lifting up the side of the car, she managed to crawl from beneath. She did not collapse, for she has always proved herself strong and courageous in emergencies. Although badly hurt, she found she could move her legs, and could even stand, with assistance, but it hurt her considerably in the pubic and sacral regions. She was transferred to another automobile that came along and taken to her home in Providence. During this ride she had a frequent desire to urinate and passed small quantities of bloody fluid.

I attended her soon after she arrived home. Found her sitting on the edge of the bed in a good deal of distress. It hurt her to sit, stand, or try to move her legs. Her underclothes were stained with a bloody fluid. Her pulse was good. She suffered pain when assisted into bed. When quiet, she was at ease, but attempts to turn in bed hurt her.

A fracture of the superior ramus of the left pubic bone was ascertained on palpation by crepitus. A catheter passed into her bladder withdrew from a half to one ounce of bloody urine. A diagnosis of ruptured bladder and fractured pelvis was made. A nurse was procured, and as no untoward abdominal symptoms were present, the patient was allowed to recover from the shock that had made its appearance.

She passed a little urine frequently during the night, which became less bloody. A catheter passed showed no urine left behind in the bladder. At ten o'clock in the morning her temperature was 99.5°, pulse 80. She had no nausea, no dullness in the flanks, no swelling in the groins, genitals or thighs. Her abdomen was becoming distended with gas and it was tympanitic all over, even over the liver region. She was very tender in the pelvic region externally, especially to her right of the median line.

An X-ray was taken of her pelvis by Dr. Hammond, which disclosed fractures of the superior and inferior rami of both pubic bones. This condition was produced by the crushing inward of the symphysis from the weight of the car on her back. The fragments of the fracture of the right superior ramus were somewhat displaced and a spicule or edge of one of the bones appeared as though it protruded somewhat inward and may have produced the wound in her bladder. The patient was conveyed to the Rhode Island Hospital in an ambulance and operated on at nine o'clock.

*Operation.*—Gas-oxygen with one ounce of ether was administered. A median incision was made from the symphysis to one inch below the umbilicus. The tissues in the region of the bladder were infiltrated with bloody urine, making it difficult to identify the peritonæum. The latter was opened, but no hole in the bladder was found on its posterior surface. Some bloody fluid deep in the pelvis may have leaked in through the peritoneal incision, or, more likely, resulted from the pelvic trauma. This was carefully mopped out and the intestines were walled off from the pelvis with gauze amputation rolls. A good deal of urine and blood was sponged out from in front of the bladder. By careful dissection and following the trail of the bloody fluid, a rent was finally found, deep down under the symphysis, and located on the anterior surface of the bladder. It was about an inch and a half long, the lower end reaching to the bladder-end of the urethra. A sound introduced into the bladder through the external meatus of the urethra served as an aid in identifying the structures and also in introducing the sutures. Two layers of the latter were used: the first to approximate the mucous coat, and the second, the serous coat. Chromic catgut was used. These sutures were taken with considerable difficulty, owing to the depth of the wound and

its location beneath the unyielding symphysis. No sharp spicule from the seat of the fractures was prominent enough to attract attention during the operation or demand correction. A cigarette drain was carried down to the wound in front of the bladder, and another behind the organ, in the peritoneal cavity. The abdominal wound was closed in layers around the wicks. Her pulse did not exceed 80 during the operation. The patient was put to bed and her pelvis swathed with a broad snug binder about her hips.

*Subsequent Notes.*—During the night she passed thirteen and one-half ounces of urine unaided and was catheterized at intervals to prevent bladder distention and cutting out of the sutures. Vomited once coming out of the effects of her anæsthetic. She was considerably distressed with gas on her stomach and was relieved by a turpentine enema, followed by small doses of calomel. The abdominal wound drained copiously requiring changes of dressings.

For the next two days the gas still distressed her a good deal. Eructations failed to relieve her, but enemas, saline laxatives and stomach washings gave her more comfort. During the afternoon of October 27, her temperature rose to  $102.4^{\circ}$  and pulse to 130. The cigarette drain behind the bladder was removed and a plain piece of rubber substituted. No bad odor was detected from the wound, which continued to drain satisfactorily, and no pus drained from it. Passed over seventeen ounces of urine herself, during the day, some also by catheter.

October 28: Less gas on stomach and more sleep last night than at any time since her operation. Temperature down to  $99^{\circ}$  and pulse 100. All drains were removed. Bowels moving freely and gas carried out by rectum. Distention of abdomen relieved. White blood count this afternoon was 14,400, polynucleated cells numbering 79 per cent., and the mononucleated 21 per cent. Temperature this evening  $101^{\circ}$  and pulse 105. Has had more restful day.

October 29: Began to menstruate yesterday. Sinus draining still and a strong odor is detected from it as though an infection from the colon bacillus were present. Smooth rubber drain inserted deep into sinus. No gas or fæces escaping from it. Distention of abdomen much diminished. Controls and voids urine very well. Temperature rose to  $101^{\circ}$  to-night again and pulse 105. No chill.

October 31: Sleeping better nights. Abdomen soft. Stomach distresses her but little now. Urine passed naturally in some quantity and also through sinus, odor being bad. Temperature  $101^{\circ}$  this afternoon.

November 2: No urine via urethra yesterday, so permanent

catheter was inserted into bladder, giving constant drainage. Temperature  $101.3^{\circ}$  last night. Few sutures were removed from wound, next to sinus, to allow unimpeded drainage. Pus beginning to escape from it.

November 6: Temperature down to  $98.6^{\circ}$  this morning for first time. Catheter drains well part of the time and refuses to work at other times, even after being cleansed. All stitches removed to-day. Eating and sleeping well. Large piece of slough picked out of wound yesterday. Temperature  $100.2^{\circ}$  this evening. Feels bones of pelvis move at times, when her position is slightly changed.

November 10: Abdominal wound cleaner. Some pus in bladder, and irrigations of boric acid solution twice a day, started. Less urine draining from abdominal wound. Temperature below  $100^{\circ}$  nights now.

November 15: Abdominal wound healthy and fast closing in. Catheter drains well and cystitis improving.

November 20: Catheter gives considerable discomfort, so has been left out for two or three hour intervals for several days. Left out altogether to-night. Bladder irrigations continued, leaving in some solution of 15 per cent. argyrol.

November 25: Less urine from sinus. Very little pus in bladder. Temperature nearly normal nights. Crepitus in pelvic bones no longer palpated when she is moved.

December 1: Holds and voids urine at will. Can move her legs a little without aid. Scarcely any discharge from sinus.

December 5: Transferred to her home yesterday. Anticipation and excitement of this event caused return of urine flow through sinus. It has been noticed that emotions influence her bladder function very much. They cause contraction of the organ with very little flow of urine through urethra, and more through abdominal wound. Relaxation of mind causes reverse process.

December 10: Sinus dry for two days. No crepitus of pelvic bones elicited on palpation when thighs are flexed. Turns a little on side in bed herself.

December 22: Sinus has remained dry since last note. Moves legs well herself without pain. To sit up in bed, daily, after this date.

December 26: Sat up in chair with legs elevated in another chair yesterday. Sinus has closed. Fractures have united.

January 1, 1916: Up in wheel chair daily. Can cross legs without discomfort.

January 16, 1916: Getting around on crutches and experiences no pain in pelvis while bearing weight on feet. Has dispensed with her wheel chair. Little pulling sensation on abdominal wound

when she straightens up. Wound has fully healed. No scab on it now.

February 25, 1916: Has used no crutch, cane, or any support for two weeks. Can walk up and down stairs. Gets up from chair and sits down without discomfort. Can stoop down and pick object from floor. Bladder gives her no trouble as to frequent desire to urinate or pain during the act. Has some backache latter part of the day yet from her exertions and tires easily. Sleeps well nights.

March 19, 1916: Took a ride in the electric cars to-day, it being her first day out of doors since her operation.

On October 6, 1916, I called on Mrs. W. at her home and found her feeling perfectly well. She complained of no urinary discomfort whatsoever. She walks as well as she ever did in her life, being free from all pain, limp, or any pelvic discomfort. Looks the picture of health. Has taken a number of rides in her machine, but has not ventured to drive it yet herself. Is very nervous when caught out on wet or slippery roads for fear of skidding. She has made a complete recovery from her very serious accident.

# INDICATIONS FOR THE IODOFORM WAX BONE-FILLING OF MOSETIG-MOORHOF\*

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IN 1903 Mosetig-Moorhof (*Zeit. f. Chir.*, 1903, xxx, 433) described his method of filling bone cavities with iodoform wax. His formula is: Iodoform, 60 parts; spermaceti and oil of sesame, each, 40 parts. These are to be mixed in a sterile pan, on a water-bath, being heated slowly up to 80° C., and the temperature of the mixture is then to be kept at 80° C. for fifteen minutes. The fluid mass is then removed from the water-bath, and is allowed to cool while being constantly agitated. This long continued agitation is extremely important in order to secure exact emulsification of the iodoform. Before being put to use, the solidified wax should be warmed up to 60° C., on a water-bath, being constantly stirred until thoroughly mixed.

Mosetig-Moorhof laid great stress on proper preparation of the bone cavity, emphasizing the necessity that it be not only sterile but also perfectly dry. The operation, of course, is done under Esmarch anæmia. Sterility is sought for, first by cutting away all unhealthy bone. This, as he says, often is a tedious job, and requires rather pedantic use of gouge, rongeur, etc. Then the cavity is irrigated with 1 per cent. formalin, or if there is the least oozing of blood into the cavity, hydrogen peroxide is employed. Next the cavity must be dried. Mosetig-Moorhof himself employed a hot air blast; but he said where this was not available cold air could be used if it was properly filtered and dried before being blown against the walls of the cavity. These walls were to be considered dry only when the glistening appearance of moisture was no longer present, as it was necessary for the wax to be applied intimately to the bony tissue, filling every crevice and even blocking the minute blood-vessels which were exposed in the walls of the cavity.

The wax, properly prepared by heating and thorough stirring, is now to be poured very slowly into the cavity until the latter is filled absolutely full. Pouring it in slowly he considered of the utmost importance in order to prevent the entrance of any air-bubbles. When the mass has solidified the soft parts are sutured without drainage,

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\* Read before the Philadelphia Academy of Surgery, December 4, 1916.



but not so tightly as to prevent the escape of exudations from the soft parts. Fistulæ and sinuses which are not included in the operative incision may be left as channels of exit for such necessary drainage.

Mosetig-Moorhof had operated on 120 cases by this method at the time of his original report; so that his method could no longer be considered in the experimental stage. In all these cases, he says, healing eventually occurred without fistulæ. In some cases, especially where the soft parts were in bad condition, a little of the wax exuded between the sutures; but the bulk of it remained in the cavity, and was slowly replaced by granulations from the surrounding bone.

Until the introduction of this method of treating bone cavities (resulting from operations for bone abscess, chronic osteomyelitis, necrosis, etc.), the only satisfactory way to secure their complete healing was to cut away all of the anterior and most of the lateral walls of such cavities, thus converting the former cavity into a shallow groove down and across which the soft parts could grow. This necessitated a very long time for complete healing of the wound, and in many cases recurrences took place because the surgeon had been too timid in removing overhanging bone at the original operation. Even when healing occurred, the scar resulting from the slow granulation of the wound was extensive, unsightly, depressed, and often so adherent to the underlying bone that slight injuries caused repeated disability.

Of course the iodoform wax filling is most easily applied and proves most satisfactory in cases of bone cavities which are sterile or nearly so at the time of operation. Thus, in cases of bone cysts (Case VI) or early and localized tuberculous disease (Case VII), primary healing usually may be expected; and even in cases of bone abscess with attenuated infection (Cases IX and X) healing usually will occur without further interference, though a sinus may persist for some months. But even in cases not as promising as those just mentioned, *Plombierung* is frequently of inestimable advantage. Thus in Case V and Case VIII, though a considerable portion of the wax was discharged during convalescence, the patients were spared the discomforts attendant upon frequent packing of the cavities with gauze; and in neither case was another operation requisite to secure permanent closure of the cavity. In Case V, moreover, a number of previous operations, in none of which was the iodoform wax employed, had been unsuccessful in obtaining cure of the disease. In Case VIII no previous operation had been done. In this connection, I think the course of events in Case I is of interest: here all the available wax (100 c.c.) was used in filling a cavity on the median side of the femur,

## INDICATIONS FOR MOSETIG-MOORHOF BONE-FILLING

and the opening on its lateral surface had to be packed with gauze. The result was that while the former wound healed without further interference, the outer wound required two subsequent sequestrotomies before permanent closure could be obtained.

One of the risks in using gauze in bone cavities is illustrated in Case II: though the surgeon who last operated upon this patient before she came under my care had filled the cavity with wax, it is evident that either then or at some previous or subsequent time a small fragment of gauze had been lost in the cavity, since I removed such a piece on reopening the unhealed cavity.

Case III was evidently an unsuitable one for treatment by bone wax. Amputation was clearly indicated, but was persistently refused by the patient and his family; death resulted from sepsis.

In Case IV (excision of the diaphysis of the fibula for osteomyelitis), while the wax probably was not necessary, yet I believe that it was useful in stimulating bony growth. At any rate, in a similar case in which no bone wax was used, the periosteal tube being allowed to fill with blood clot, complete regeneration of the bone did not occur, although a less extent of the fibula was removed (also subperiosteally) than in the case reported herewith.

In a number of cases, not recorded here, I have endeavored to sterilize the cavity by means of a hot air blast, as originally recommended by Mosetig-Moorhof. By employing the electric apparatus used for hot air douches (in the treatment of lumbago, etc.), and conducting the air into the cavity by means of a glass tube, I found the current of air could be delivered at a temperature of  $100^{\circ}$  C. But I found that this was not sufficient to sear the cavity, and I have been assured by bacteriologists that air could not be sterilized with certainty in so short a space of time as is required for its transit through this apparatus unless it were raised to a temperature of  $300^{\circ}$  C. Nor have I found radiant heat from the actual cautery more efficient. So of late I have abandoned any such methods, and content myself with chemical sterilization (phenol, iodine, alcohol) and mechanical drying.

The following case histories are selected as exemplifying the main indications for the use of the iodoform wax bone-filling.

CASE I.—Sequestrotomy for necrosis of femur. Alice McG., seventeen years of age, when first seen in 1908 had had several operations for chronic osteomyelitis of the left femur, but several sinuses remained above both the external and the internal condyles, through which bare bone could be felt; and from time to time there were more or less acute exacerbations due to pocket-

ing of pus. She was admitted to Dr. G. G. Davis's service at the Orthopædic Hospital, and operation was done May 14, 1908.

*Operation* (Dr. Ashhurst).—Under Esmarch anæmia three sequestra were removed from beneath an involucrum on the median side of the femur; the resulting cavity was filled with the iodoform bone wax (100 c.c.) and the soft parts were tightly sutured over it. The outer surface of the femur was exposed and curetted, and a button of bone was removed by a trephine, but as the bone appeared healthy here the marrow was not exposed. The outer incision was packed with iodoform gauze, as all the available wax had been consumed in filling the inner cavity.

The temperature rose to 102° F. on the day after operation, but gradually fell to normal. One month after operation the girl went home on crutches, there having been some discharge from both incisions.

July 14, 1908: Two months after operation she walked without a crutch, and the knee could be fully extended. This was impossible before operation. Both sinuses still discharged.

November 3, 1908: Scarcely any limp.

September 15, 1910: A sinus on the outer side persists, but there is no disability.

October 25, 1910: Inner sinus has again been moist for a few weeks.

June 1, 1911: Outer sinus has never entirely closed since last operation (iodoform gauze packing). The inner sinus has been closed for eight months, with exception noted in October, 1910 (bone-wax filling used on this side of femur). To-day carious bone was curetted above the external condyle; no sequestra were found. The wound was filled with iodoform bone wax and the soft parts were sutured tightly over it. A sinus formed here later.

November, 1911: Dr. Davis curetted and gouged the femur above the external condyle.

February, 1912: Several sequestra were spontaneously discharged from the remaining sinuses.

May, 1912: Scarcely any discharge, and only from sinus on outer side of femur.

June 14, 1916: The patient was examined again. The sinuses have remained healed since November, 1913. The knee flexes to 100 degrees and extends to 180 degrees. There is no disability, in spite of the marked thickening of the femur.

CASE II.—Bone abscess of tibia, removal of scrap of gauze from cavity. Elizabeth M., twenty-one years of age, was first seen in December, 1909, in Dr. Frazier's service at the Episcopal Hospital. It was a case of chronic osteomyelitis of the left tibia, of eight years' duration, for which fifteen distinct operations had

## INDICATIONS FOR MOSETIG-MOORHOF BONE-FILLING

been done. The last operation, in February, 1909, consisted in curettement and gouging of carious bone; the cavity had been filled with iodoform bone wax, but most of this had been discharged when the skin sutures were removed. Since this operation a small sinus and scab had persisted. For the last two months there had been worse pain, at times very severe. A skiagraph showed an involucrum in the upper third of the tibia, with apparently normal medulla above and below. Though a sequestrum was not visible, it was thought one must be present to account for the pain and persisting sinus.

*Operation* (December 17, 1909) (Dr. Ashhurst).—Esmarch anæmia. The old cicatrix and sinus were excised, and the periosteum reflected. When the cortex had been cut away, there was found not a sequestrum, but a bit of old gauze (Fig. 1), about half an inch square, which presumably had become lost in the cavity at a previous operation or dressing. The cavity in the bone was filled with iodoform bone wax and the soft parts tightly sutured.

January 15, 1910: The wax, which began to discharge when the sutures were removed, is still discharging.

January 20, 1910: Went home.

December 4, 1916: Patient reports that five or six subsequent operations have been done on her tibia, but that it has now been firmly healed for three years, though occasionally painful and tender.

CASE III.—Bone abscess of tibia. Andrew B., aged sixty-three years, was admitted to Dr. Frazier's service in the Episcopal Hospital September 9, 1911. Nine years before an abscess over the tibia had been opened by Dr. G. G. Davis under local anæsthesia. The incision soon healed and no further trouble had been experienced until about two weeks before his second admission, during which period there had been tenderness, redness and pain over the upper end of the right tibia. On admission the tibia was found thickened, with tenderness and redness and constant pain. The temperature varied from 101° to 103° F., and the leucocyte count was 10,720, with 88 per cent. polynuclears. The man was old for his years, feeble, and evidently seriously ill.

*Operation* (September 11, 1912) (Dr. Ashhurst).—Under Esmarch anæmia. Pus was found beneath the deep fascia. There was no cloaca on the subcutaneous surface of the tibia. The periosteum, which was thickened and did not strip easily, was reflected and the cortex removed. An abscess containing 10 to 15 c.c. of pus was found in the medulla. (Culture of this pus gave a growth of diplococcus. Histological examination of the bone showed osteomyelitis, with no evidence of tuberculosis.

Dr. C. Y. White.) The entire medulla and cortex throughout the upper third of the tibia (except extremely thin shell of cortex) was riddled with pus, and the bone was easily removed by Volkmann's sharp spoon. The knee-joint was opened at one point through a perforation in articular cartilage of tibia. The entire anterior wall of the cavity was cut away until apparently healthy bone was exposed in all places. No cloaca was found anywhere. The pus which was found beneath the deep fascia must have perforated the cortex through one of Volkmann's canals. The cavity was swabbed with very hot carbolic acid (pure phenol), and then flooded with alcohol, and finally dried with gauze. The cavity was filled with iodoform bone wax, requiring 120 to 150 c.c. The soft parts were closed as securely as possible. It was noted that amputation probably would be required.

The patient did badly, became delirious at night, and six days after operation the knee-joint was found swollen and painful, with much pus discharging from the wound. The patient and his family repeatedly refused amputation, and death occurred September 30, three weeks after operation, from sepsis.

CASE IV.—Excision of diaphysis of fibula for osteomyelitis. Rose H., twelve years of age, was first seen in Dr. Davis's service at the Orthopædic Hospital in May, 1912. In October, 1911, the girl had fallen over a rope and hurt her right leg. It swelled up, and in November, 1911, two incisions were made by the family physician under a general anæsthetic, and the wounds were packed with gauze for a long time subsequently. When seen at the Orthopædic Hospital the whole outer side of the right calf was bluish, the skin thickened and hard; two sinuses were discharging pus: one, above the middle of the fibula, the other just above the external malleolus. A skiagraph showed the fibula thickened to the size of the tibia, and at the upper sinus a sequestrum projecting from the cortex. There was no evidence of recently formed subperiosteal bone, nor of a marrow cavity, nor of an internal (tubular) sequestrum.

*Operation* (May 10, 1912) (Dr. Ashhurst).—Under Esmarch anæmia the entire diaphysis of the fibula was removed by twisting out each end, after sawing through its centre. Numerous small areas of subperiosteal bone were left attached to the periosteal tube. After suturing the periosteum, deep fascia and skin, except over the centre of the incision, the periosteal tube was injected with iodoform wax. The centre of the incision was then closed tightly, the wound dressed, and the Esmarch band removed. A plaster-of-Paris dressing was then applied from toes to upper thigh.

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May 12: Temperature 102° F. No symptoms. X-ray shows wax only in central portions of periosteal tube.

May 15: Temperature normal since May 12. First dressing through window in gypsum case. Moderate purulent discharge from two ends of incision.

July 23, 1912: Has been walking without support for three weeks. Incision firmly healed for one week. Skiagraph shows nearly complete regeneration of fibula.

March 11, 1913: Skiagraph shows complete regeneration of fibula, 10 months after operation.

March 23, 1914: Presented at a clinical meeting of the Philadelphia Academy of Surgery, held at the Episcopal Hospital.

CASE V.—Recurrent osteomyelitis of tibia. Philip R., sixteen years of age, was seen in Dr. Frazier's service at the Episcopal Hospital, in December, 1912. In April, 1912, the right knee became painful and tender following a slight injury, and after being at home a few days in bed he was admitted to Dr. Mutschler's service in the Episcopal Hospital, April 9, 1912. Two days later Dr. Mutschler made an incision through the periosteum of the tibia, finding subperiosteal pus. The cortex was not incised. The boy did not do well, and on June 28, Dr. Mutschler operated again, finding new-formed subperiosteal bone; this time the medulla was opened and drained. In October, 1912, and again in November, 1912, Dr. Frazier removed some necrotic bone.

December 10, 1912: For the last few days there has been tenderness and redness and pain around the head of the tibia, this being a part of the bone not explored at any of the former operations. There are now gutters in the upper and lower thirds of the leg, with an area nearly healed in at the middle third. The foot is in slight permanent equinus. The boy is thin, pale and anæmic.

*Operation* (December 11, 1912) (Dr. Ashhurst).—Esmarch anæmia. The cicatrix in the upper third of the tibia was excised, and the head of the bone was exposed. Little periosteum was left; the cortex was gray, spongy and soft, and infiltrated with pus. There was an abscess in the medulla extending up to the epiphysial cartilage. The cavity was swabbed with pure carbolic acid, flooded with alcohol, dried, and filled with iodoform bone wax (50 to 75 c.c.) (Fig. 2). By undermining the skin this could be sutured tightly over the wax. The leg was dressed on an inclined plane in a fracture box.

December 15, 1912: There has been no rise in temperature nor any unfavorable symptom since operation. Subsequently, when the sutures were removed, some of the wax discharged through the opening.

March, 1913: There remains an opening three inches long and one inch deep at the upper end of the tibia; this is covered with healthy granulations.

June, 1913: Granulating area at upper end of tibia, 2 cm. deep.

September, 1913: Upper area of granulations only 5 cm. long and shallow. In lower part of leg only a superficial ulcer remains. Gradual healing after this date.

November 22, 1915: Reports now because of painful swelling over *left* tibia. The right leg is not yet completely healed, as the scar is thin and adherent to the bone, and easily breaks down.

November 23, 1915: The swelling over the left tibia was exposed under Esmarch anæmia: the periosteum was thickened and was partly responsible for the spindle-shaped swelling. The cortex, which was removed by gouge, was very thick and sclerosed. The medulla when exposed was apparently normal. The overlying cortex was removed for a distance of about 10 cm. (A culture from the medulla remained sterile. The bone specimens were lost in the laboratory.) The cavity was filled with iodoform bone wax, and the soft parts were sutured tightly. Then the adherent cicatrix was excised from the right tibia, and the skin closed without tension by undermining its edges.

December 9, 1915: The boy was allowed to go home. There had been a slight oozing of wax from the incision in the left leg. The right leg was healing well.

November, 1916: The boy was seen on the street several months after leaving the hospital, and appeared to have no disability. As he has not returned for further dressings, it is presumed the incisions have given no further trouble.

CASE VI.—Bone cyst of tibia. Columbia G., five years of age, for two or three years had had swelling above the left ankle. For the last four or five months there had been pain and a limp. She was admitted to Dr. Frazier's service in the Episcopal Hospital. Skiagraphs showed a cyst in the lower end of the tibia. (Figs. 3 and 4.)

*Operation* (August 27, 1913) (Dr. Ashhurst).—Under Esmarch anæmia a curved incision was made over the subcutaneous surface of the lower end of the tibia. The periosteum was a little thickened, and the cortex slightly hyperæmic. The cortex was about 2 mm. thick, and on removing this a yellowish-white cyst wall bulged into the opening. On cutting through this with scissors, some semifluid matter, which resembled tuberculous pus, oozed out, and then considerable cheesy matter, but no fluid. There was a good deal of carious spongy red bone surrounding the cavity, and it was thought to be a tuberculous abscess of bone. On the posterior wall of the cavity the cyst had perforated the

## INDICATIONS FOR MOSETIG-MOORHOF BONE-FILLING

cortex over an area about 3 mm. in diameter. The cyst cavity was the size of a pigeon's egg, and extended down to the epiphysial cartilage. The cavity was scraped clean, and filled with bone wax (Fig. 5). The soft parts were closed without drainage, and a plaster-of-Paris dressing was applied.

September 3: Gypsum dressing removed, on account of pain in the leg. A little of the wax was found discharging between two sutures. A new gypsum case was applied, with a window over the wound.

October 3: No discharge from the wound since last note. Wound now healed.

November 28: Sent home, walking, in light brace. A skiagraph (Fig. 6) showed considerable concentric growth of bone around the iodoform wax filling, which has been slightly absorbed.

February 12, 1914: Six months after operation. The leg seems normal. The foot does not dorsiflex beyond 90 degrees. She continues to wear the brace. Circumference of right calf, 21.5 cm.; of left calf 18.5 cm.

November, 1916: A report from this patient was secured through the Social Service Department of the Orthopædic Hospital. There is no apparent disability, and the wound continues closed.

*Pathological Report* (Dr. C. Y. White).—Culture and smear from cyst negative. Unfortunately the cyst wall and contents were mislaid in the operating room, and did not reach the laboratory in fit condition for histological study or for inoculation into guinea-pigs.

CASE VII.—Tuberculous cyst of ulna. James C., when about six years old, fell and hurt his left elbow. He seems to have suffered no particular disability as a result, but two years later (July, 1914) applied to the Orthopædic Dispensary of the Episcopal Hospital for limitation of motion. There was decided limitation of rotation in the forearm, and the elbow flexed only to 50 degrees and extended to 130 degrees. There was no pain, no heat, and only slight thickening of the elbow region. A skiagraph showed a cystic condition of the upper end of the ulna, apparently extending to the joint surface (Figs. 7 and 8). It was thought to be a "benign bone cyst," and, after keeping the child under observation for four months, and finding no change in the local condition, operation was advised and accepted by the parents.

*Operation* (November 4, 1914) (Dr. Ashhurst).—Under Es-march anæmia an incision was made over the subcutaneous surface of the ulna below the olecranon. The periosteum was incised and reflected. The cortex appeared unduly inflammatory, with a large number of bleeding points (much as the tibia in Case VI); the



cortex was soft and easily removed by a gouge, without the use of a hammer. The cortex was 0.5 cm. thick, and when it was removed a smooth fibrous layer was exposed, which constituted the cyst wall. Enough of the overlying cortex was removed to expose the cyst wall fairly well, over an area approximately 2 by 4.5 cm. An attempt was then made to enucleate the cyst without rupture, but this proved impossible, since at the coronoid process of the ulna and over the entire articular surface the cyst wall was densely adherent to the bone, dipping down into irregular notches and depressions. Those portions of the cyst wall which were not removed along with the cyst contents were scraped off the adjacent bone with the sharp spoon. The contents of the cyst resembled granulation tissue; no fluid was present. The cavity in the ulna was filled with iodoform bone wax (Fig. 9) and the periosteum and then the skin tightly sutured. The Esmarch band was not removed until after the dressings had been applied. The pathological study of the specimen (Dr. C. Y. White) showed tuberculous osteomyelitis; injection of the tissue into a guinea-pig was positive for tuberculosis. This report is of interest, especially as the X-ray picture did not suggest a tuberculous process. The skiagraph is practically identical with that of the second case reported as chronic fibrocystic osteomyelitis by Barrie (*Surgery, Gynecology and Obstetrics*, 1914, xix, 42, Fig. 2).

November 23, 1914: There has been a little discharge of wax since operation.

December 7, 1914: Wound is firmly healed.

December 18, 1914: Plaster-of-Paris case applied, the laboratory report of the tuberculous nature of the lesion having been received.

March, 1915: Gypsum case removed, and arm carried in a sling.

May, 1915: As heat in elbow persists, an internal angular splint was applied, in addition to the sling.

June, 1915: No heat or swelling. Splint removed.

July, 1915: Sling discontinued.

October, 1915: Motion 50 degrees to 120 degrees. Never any pain.

August, 1916: Motion 70 degrees to 140 degrees. No symptoms.

November, 1916: Motion 45 degrees to 115 degrees. Plays ball and has no disability. If motion does not improve when epiphysial growth is complete, excision of the elbow may be advisable. A skiagraph shows no vestige of wax remaining; the upper end of the ulna is rarefied, but much of the cortex has reformed, apparently of normal density.

## INDICATIONS FOR MOSETIG-MOORHOF BONE-FILLING

CASE VIII.—Necrosis of radius. Joseph P., nine years of age, September, 1915, came to the Orthopædic Hospital with running sores in his left forearm. The trouble began acutely about one year previously, with pain, swelling, and disability in the left forearm, the height of the attack being reached within one day of its onset. He was in a hospital for seventeen days, but no operation was done. Two months later sinuses formed, and later still his family physician made an incision over the head of the radius. This is the only opening that has healed. Three sinuses are still open: one above the internal condyle of the left humerus, one below the flexure of the elbow, and one above the styloid process of the radius. The discharge is profuse and very foul; and the radius is thickened. Supination is lost, and there are only 30 degrees of motion in the elbow. A skiagraph shows a long sequestrum present beneath an involucrum of the radius, in which two cloacæ are visible. The epiphysis of the head of the radius is displaced in front of the elbow-joint, but the remainder of the radius is not dislocated (Fig. 10).

*Operation* (September 11, 1915) (Dr. Ashhurst).—Esmarch anæmia. Incision upward from radial styloid, excising the lowest sinus. The superficial radial nerve was identified, and followed up to the interval between the brachioradialis and the extensor carpi radialis longior, thus baring the shaft of the radius to above the attachment of the pronator teres. The involucrum was 2 cm. thick, and the two cloacæ seen in the skiagraph corresponded to the two sinuses in the soft parts. Through these the long sequestrum was visible. The involucrum was cut away from one cloaca to the other, a distance of 12 cm., and the sequestrum was removed (Fig. 11). It was a cortical sequestrum, evidently part of the original cortex, the involucrum being formed by new subperiosteal bone. Exploration of the sinus above the internal condyle showed that it led to the region of the head of the radius. A second incision was made, therefore, over the head of the radius, and the radius bared, and a tunnel made directly through its head, in the search for another sequestrum. None was found, but on introducing a curette into the sinus above the internal condyle a moderate amount of pus was evacuated, and the epiphysis of the radial head was found lying loose in the sinus as a sequestrum (Fig. 11). The bone cavities were dried by radiations from the Paquelin cautery, filled with iodoform bone wax, and the soft parts tightly sutured, except the old sinus above the internal condyle.

September 18: The incisions have broken open, but there has not been much discharge of pus or wax (Fig. 12).

September 27: Most of the wax seems to have been discharged, and the incisions are closing in.

February, 1916: The boy has been at a convalescent home since the autumn. The incisions are all healed; only a scab remains over the head of the radius, and in the centre of the long incision over the lower radius. There is motion in the elbow from 80 degrees to 120 degrees; the forearm is in almost complete pronation, and little rotation is possible. An abscess in the axilla has recently formed and has been opened, leaving a mass of lymph-nodes, which were excised in March, 1916.

November, 1916: All sinuses remain closed. Range of motion a little greater.

CASE IX.—Bone abscess of tibia (Markoe's abscess).<sup>1</sup> Harriet C., thirty-nine years of age, had had disease of her right tibia ever since she was fifteen years old. For twenty-four years a sinus had persisted over the upper end of the crest of the tibia, where the bone was thickened (Figs. 13 and 14). She was admitted to the Episcopal Hospital.

*Operation* (November 9, 1915) (Dr. Ashhurst).—Esmarch anæmia. The sinus in the soft parts was excised, and the bone overlying the abscess cavity was removed by gouging. The cavity contained reddish-brown granulation tissue. Pathological examination of this tissue gave a "mixed growth" and there was no histological evidence of tuberculosis (Dr. C. Y. White). No normal medullary cavity was exposed, the bone surrounding the abscess cavity on all sides being inflammatory, and resembling in appearance that seen in cases of staphylococcic inflammation. The cavity was filled with bone wax, and the soft parts tightly sutured over the bone. The Esmarch was removed after the limb had been dressed.

November 24, 1915: Upper portion of incision has healed solidly, but some wax exudes below.

December 8, 1915: Went home, using crutches. A small sinus remains, which is barely moist.

November 8, 1916: Reports for examination one year after operation. The incision has been firmly healed since June (five months). There is no disability.

CASE X.—Bone abscess of tibia (Markoe's abscess). Eugene S., thirteen years of age, cut his left leg by a knife, in May, 1915, injuring the bone below the knee. He came to the Episcopal Hospital in December, 1915. In July he had begun to complain of pain in this region, and after three weeks of increasing dis-

<sup>1</sup> "Markoe's abscess," described by Thomas M. Markoe of New York, in his "Treatise on Diseases of the Bones" (1872), as "*chronic sinuous abscess of bone*."

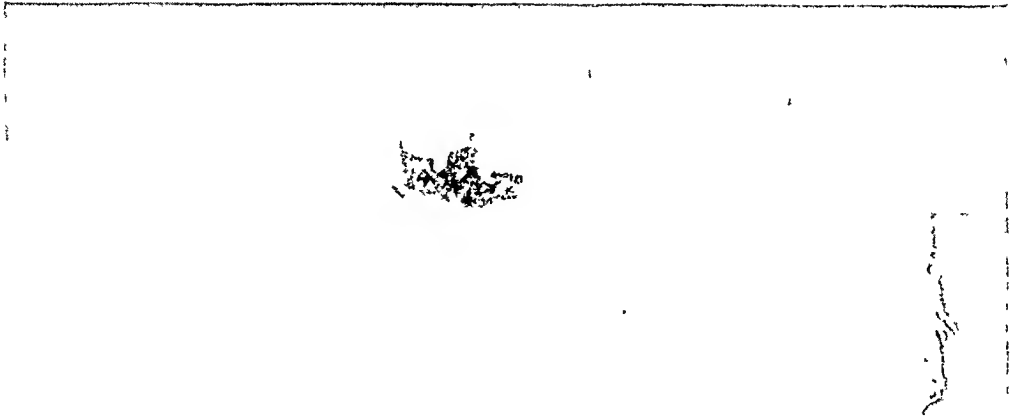


FIG 1 —Case II. Fragment of gauze (from previous operation) removed December 19, 1909, by sequestrotomy.

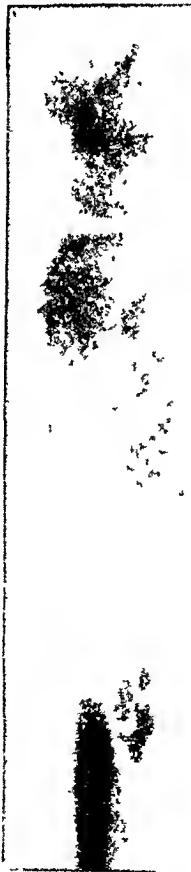


FIG. 2.—Case V. Iodoform bone wax in cavity of tibia, one week after operation.



FIG. 3.—Case VI. Bone cyst of tibia.



FIG. 4.—Case VI. Bone cyst of tibia.



FIG. 5.—Case VI. Cavity in tibia filled with wax, a few days after operation.



FIG. 6.—Case VI. Eleven weeks after operation, showing partial absorption of bone wax filling.

FIG. 7.



FIG. 8.



FIGS. 7 and 8.—Case VII. Tuberculous cyst of ulna, two years after injury.



FIG. 9.—Case VII. Iodoform bone wax in cavity of ulna, a few days after operation.



FIG. 10.—Case VIII. Necrosis of radius, one year after onset. Cortical sequestrum in shaft of radius surrounded by involucrum; also epiphysis of head of radius detached as sequestrum.



FIG. 11.—Case VIII. Sequestra from radius. Small one is epiphysial centre of head of radius. Large one is cortical sequestrum from shaft (embedded in new subperiosteal bone).



FIG. 12.—Case VIII. One week after sequestrotomy and *Plombierung*.

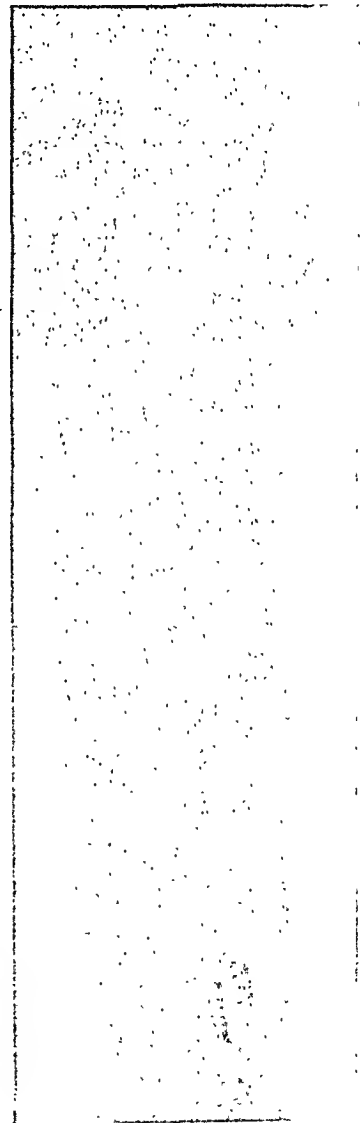


FIG. 13.—Case IX. Chronic sinuous abscess of tibia for twenty-four years (Markoe's abscess).



# TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting, held December 4, 1916*

The President, DR. CHARLES H. FRAZIER, in the Chair

## SUBPERITONEAL HEMORRHAGE, RESULT OF PURPURA HÆMORRHAGICA SIMULATING APPENDICITIS

DR. I. M. BOYKIN reported the history of a boy, aged six years, who was admitted to the Episcopal Hospital August 21, 1916, supposedly suffering from an appendiceal abscess. His previous general health had been good up to three days before admission, when he began to complain of severe pain in the abdomen, with vomiting. The child was kept in bed until the third day, when the family physician made the diagnosis of appendicitis and on his recommendation the child was brought to the hospital.

After admission he lay in bed with his right thigh acutely flexed on the abdomen and the member could not be extended without agonizing pain. There was a decided pallor. Just above Poupart's ligament on the right side was a mass, well defined and tender. There was slight rigidity of the right side of the abdomen, the left side seemed normal. In the left anterior tibial region were two ecchymotic spots about the size of a dime, which were presumed to be bruises.

Reflexes normal. Temperature  $101^{\circ}$ , pulse 100, respirations 28, leucocytes 14,000. The history and the data elicited by examination were in favor of an appendiceal abscess.

The child was taken directly to the operating room and under ether anæsthesia an incision made over the top of the mass. The blood that flowed into the skin incision was very dark. The abdominal muscles were almost black. The peritoneum was opened and the appendix presented in the wound, apparently normal. The peritoneal fluid was in excess and slightly blood tinged. The mass, which was felt through the abdominal wall, was found to be retroperitoneal and to consist of a blood clot. The patient's condition would not permit further investigation, so a cigarette drain was inserted and the abdomen closed. The patient died the same evening without reacting.

Several hours before death it was noticed that, in addition to the two ecchymotic spots on the left tibia, there were many others on the

## INDICATIONS FOR MOSETIG-MOORHOF BONE-FILLING

ability an abscess had been lanced, in August, 1915. Since then a sinus had been present over the head of the tibia, at times scabbed, but usually weeping a little thin pus. Small pieces of bone had been discharged occasionally. A skiagraph showed a cavity in the upper end of the tibia.

*Operation* (December 8, 1915) (Dr. Ashhurst).—Esmarch anæmia. A flap of skin was turned up from the head of the tibia, with its base on the fibular side. The sinus led into the tibia just below its tubercle on the median side of the bone. The overlying bone was removed by gouge, and the abscess cavity exposed. This was found to extend through the cortex posteriorly over a small area, where the abscess cavity was limited by periosteum. The tibial crest was not removed, but by gouging away the lateral as well as median surfaces of the tibia, the abscess cavity was fairly well exposed. The surrounding bone, infiltrated with puriform matter, was scraped away by Volkmann's spoon until healthy hard bone was reached on all sides, and until healthy red marrow was exposed below. The cavity was then filled with 3 per cent. iodine solution, and when this was wiped out it was replaced with iodoform bone wax, about 30 c.c. being required. The periosteum and skin were closed separately over the wax, as securely as possible. After dressing the wound the Esmarch was removed.

The pathological report on the tissues (Dr. C. Y. White): Chronic granulation tissue; guinea-pig injected remained negative for tuberculosis. Smear from pus showed a large diplococcus.

December 19: A skiagraph shows the wax filling the cavity (Fig. 15).

January 22, 1916: Went home, incision almost dry.

February 21, 1916: A skiagraph shows the wax all gone: most of it has been absorbed, as no recognizable quantities have been discharged.

November 8, 1916: A small sinus remained moist until last June. Since then it has been open only one day. The incision is now firmly healed.

Dr. Kelly made a diagnosis of tearing of the iliopsoas muscle attachment. X-ray picture showed a separation of the lesser trochanter of the right femur without other fracture.

From the history of this case it is difficult to say whether the separation of the lesser trochanter occurred at the primary traumatism of a year ago from direct violence or at the second accident when the exciting force was applied by the pull of the iliopsoas muscle. It seems probable that the injury followed the first trauma and recurred at the second injury.

The condition was met by placing the limb in a plaster case in a position of semiflexion and extreme adduction. This at once relieved his pain. After three weeks the case was removed and the patient given massage and passive motion. At the present writing the patient uses the limb without discomfort or any limitation of function.

HUTCHINSON (*British Med. Jour.*, December 30, 1893, p. 671) reports a case of Fenwick's in a boy of seventeen, who leaped from a fence and fell backward, breaking off the lesser trochanter, apparently by the pull of the psoas iliacus. This was verified by incision. The patient died of septicæmia on the seventeenth day.

JULLIARD (*Progrès Méd.*, 1879, vii, p. 825) reports a case of a man, eighty-two years of age, who was injured by falling as he rose from bed. He suffered from marked pain, eversion, and disability until death. The autopsy showed a large extravasation of blood in the muscles. The joint and neck of the femur were intact and the lesser trochanter was broken off and adherent only by a strip of periosteum. There was, however, a small area at the upper extremity of the femur which showed sarcomatous degeneration.

ASHHURST (*Surgery, Its Principle and Practice*, 1914, p. 368) mentions eight cases, collected by Binet and Hamant (1911), of isolated fracture of the lesser trochanter, and says that isolated fracture of the great trochanter occurs and may require periosteal suture to maintain reduction.

METCALF (*Jour. of Amer. Med. Asso.*, 1915, lxiv, 1234) collected fifteen cases since 1854. This list includes the eight cases collected by Binet and Hamant in 1911. Metcalf does not include the case of Fenwick's reported by Hutchinson as mentioned above. This would make the total sixteen up to 1914. Metcalf reports two cases from his personal experience. This brings the total up to eighteen cases to 1914. Since that time I have been unable to find any reports of such cases and my own case would bring the total up to nineteen.

Fracture of the lesser trochanter complicating other injuries to the femur is not an uncommon occurrence. Ashhurst (*ANNALS OF SURGERY*, 1913, lviii, 494) mentions six cases admitted to the Episcopal Hospital, Philadelphia, during six months with fracture of the lesser trochanter complicating fracture through the trochanter.

Metcalf's first case in a patient seventeen years of age was due to a bump from a fellow player, causing the right limb to slip suddenly backward. His second case was in a boy of sixteen years, who while running in a football game wheeled quickly to the right to catch a

## AVULSION OF LESSER TROCHANTER OF FEMUR

lower extremities and also on the abdomen in the region of the wound.

A postmortem could not be obtained, but the wound was reopened and enlarged. Unsatisfactory as it was, the following important points were noted: Wherever the intestines were touched at time of operation there were ecchymotic spots, almost corresponding to finger prints. There was a retroperitoneal blood clot, extending from Poupart's ligament to the upper pole of the right kidney. The peritoneum was adherent to clot at a point corresponding to that of the patient's pain. The clot was removed and the ruptured vessel looked for but none was found. Both kidneys were taken out and incised. In the cortex and medullary portions of both were found small hemorrhages; a blood clot was found in the pelvis of both.

### AVULSION OF THE LESSER TROCHANTER OF THE FEMUR (EPIPHYSIAL SEPARATION)

DR. GEORGE G. ROSS related the history of a boy, fifteen years of age, who, on June 24, 1916, while playing baseball, received an injury to his upper right thigh. He struck a ball and started to run for first base; after the third stride he fell to the ground. The pain, which was in the right groin, was severe and prevented walking, as attempts at flexion of the thigh on the body markedly increased the pain. He could stand with fair comfort and was relieved when the limb was in flexion and adduction. On attempting movement he said it felt as though there was a marble in his groin. Passive motion did not cause pain. There was tenderness on deep pressure both over Scarpa's triangle and on the posterior surface of the thigh. There was no ecchymosis or swelling. Dr. Kelly, of the Germantown Hospital, who brought him to the hospital, found him lying on his left side with the right thigh semiflexed and adducted.

One year prior to the present accident, the patient was butted in the right groin by another boy's head, causing him to fall backward. He had severe pain in the right groin which he said felt like a muscle bruise. He limped for a week and felt a grating sensation for some months and was unable to take exercise due to soreness and inability to lift the thigh. Pain was relieved by recumbency. Later he was able to take exercise and felt no discomfort. He said that the day before his second accident he felt some soreness in the groin with some interference with flexion.

The patient had had measles, chicken-pox, mumps, pertussis, but never had tonsillitis. His family history was negative, except for one uncle who has tuberculosis, but this uncle does not live in the same house with the patient.





FIG. 1.—Avulsion of lesser trochanter of the femur.

flexion of the thigh. Dr. Metcalf, physician to the school, had an X-ray taken on the following day which showed apparently partial detachment of the epiphysis of the lesser trochanter. The leg was most comfortable when kept slightly flexed. He was treated with a plaster case for nearly three weeks. There was no localized tenderness or swelling. After the plaster case was removed a leather splint was applied which embraced the thigh and pelvis. When seen January 9, 1915, he had been walking with the splint but without crutches since December 21, 1914. Examination at this time showed nothing except slight atrophy of the thigh muscles. X-ray was taken by Newcomet, which confirmed diagnosis of fracture or avulsion of the lesser trochanter of the femur.

Patient states that a similar case occurred in the same school within a year or two, the boy being injured while playing hockey. This patient also was able to walk around for a few hours after the accident.

DR. HENRY R. WHARTON said that some years ago, before the days of the X-ray, he had a patient admitted to the Children's Hospital, of about ten years of age, who had fallen downstairs and struck at the foot of the stairs with violent separation of the thighs. There was great tenderness on the anterior of the thigh and of the pelvis posteriorly. He imagined there was a muscular lesion. A few days later there was high temperature and an abscess developed in the right groin which was incised. There was found to be separation of the epiphysis of the lesser trochanter. The patient finally made a recovery. Looking up the literature at the time he found the condition to be comparatively rare, and that septic infection was not uncommon.

DR. P. G. SKILLERN, JR., remarked that owing to the low, sessile nature of the lesser trochanter, actual fracture of this process in the adult must be much rarer than its disjunction as an epiphysis during the period of adolescence, or between the ages of eight and nineteen years, the epiphysis appearing at about the eighth year and uniting with the shaft at the nineteenth year. A case has been recorded in which this epiphysis was torn off in a boy of fourteen, as the result of the strain on the iliopsoas in a fall backward on the feet. Death from pyæmia followed. The majority of cases occur in this epiphysial age. Roberts and Kelly cite three cases which occurred in men beyond middle life, in which the injury was due to muscular pull in falling. In one case the patient was run over by an omnibus. The injury is due to the pull of the iliopsoas muscle.

Dr. Ross stated that he dressed the limb in the position of flexion with adduction. It is surprising how much tension may be taken off of the lesser trochanter and relaxation obtained by the manœuvre of

## AVULSION OF LESSER TROCHANTER OF FEMUR

forward pass and as he did so his left limb dragged behind in extension and he fell to the ground.

Metcalf gives four symptoms: Pain, slight when quiescent, increased on walking and flexing thigh; other motions little or no effect on pain; tenderness on direct pressure over the lesser trochanter.

In this case flexion was impossible beyond one or two inches. Voluntary flexion caused intense pain. Passive motion did not cause any discomfort. Pain was elicited on pressure over the lesser trochanter, both on the anterior and posterior surface of the thigh.

Loss of function, either partial or complete. Some of the cases were able to walk but stiff-hipped and with discomfort. Loss of function was the observation in most of the cases, although Brunelli's case continued his occupation for a week after the accident. Deformity—Eversion was noted in adults. Chaput's case, aged fifty-two, held his leg in external rotation flexion and abduction. Gray noted external rotation which could, however, be readily overcome. In young persons there seems to be no reported deformity. There certainly was not in this case. The limb was held in adduction and semiflexion to relieve the pain; this was postural and not deformity. In old people there is reported ecchymosis and swelling; here again differing from the younger patient. In Metcalf's cases these signs were absent, as they were in this case. The diagnosis rests therefore on a history of trauma in which the applied force is directed through the iliopsoas muscle to the lesser trochanter and localized pain and tenderness in the groin. Inability to flex the thigh or if flexion is possible it is according to Ludloff's sign. With the patient on the back he can lift his thigh by using the rectus femoris, but is unable to flex the thigh while in a sitting position. Localized swelling and pain may be present or absent according to the age or youth of the patient.

Treatment should be non-operative. As one cannot bring the small fragment down to its normal position on the femur, bring the femur up to meet the fragment and retain in a fixed dressing in semiflexion and adduction.

DR. JOHN H. JOPSON added the history of a boy of sixteen years, whom he saw in consultation with Dr. Girvin, January 9, 1915. On November 10, 1914, while playing football and running after a forward pass, the boy turned to the right and fell with the thighs flexed. He experienced slight pain and a sensation of something giving way in the upper inner region of the thigh, sensation being described by him as similar to that of "putting elbow out." Immediately after the accident he could not use the knee well, but was able to walk home. In the evening, while walking, pain became very severe and interfered with



## PYLORIC AND DUODENAL ULCER

DR. JOHN B. DEEVER presented a series of lantern slides (see Figs. 2-11). He said his purpose was to elicit views upon the surgical technic in the treatment of these ulcers. Taking up first ulcers of the stomach; we know their most common site is on the posterior wall along the lesser curvature, near the pylorus; next most common site lesser curvature distant to the pylorus and the anterior and posterior walls. The least common site, in the fundus and to the side of the entrance of the œsophagus. When possible all ulcers of the stomach should be excised; this is practically always possible where they occupy either the anterior or posterior wall of the stomach. When the ulcer is on the posterior wall the excision is made transgastrically. When the ulcer is small and on the lesser curvature it can be excised and the stomach walls repaired without interference with its mechanics. Where the ulcer is large and on the lesser curvature, and particularly when of the saddle-back type, involving both walls, central resection with end-to-end union is the operation of choice, a gastro-enterostomy not being necessary, at least he had not found it so. In pyloric ulcer with considerable induration he believed the better practice is to do pylorectomy, at least this is the technic he practised. Ulcers in the fundus and around the œsophageal entrance are practically inoperable, at least those that have come under his observation have been. He believed, however, if these were diagnosed very early by making a gastrotomy in doubtful cases, much can be accomplished.

It is a well recognized fact that duodenal ulcer is more frequent than gastric ulcer. Duodenal ulcer is most often located upon the anterior and lateral wall of the first portion of the duodenum. The next most common site is the posterior wall of this portion of the intestine, and the least common site the inner pancreatic wall of the second portion of the duodenum.

Where the ulcer is small and located upon the anterior wall of the first portion of the duodenum it is his practice to excise it, close the opening in the intestine, plicate the duodenum and make a posterior gastro-enterostomy. When an ulcer in this portion of the intestine is large, but extending short of the head of the pancreas, he amputated the duodenum below the lesion, purse-string it, invert, excise the pylorus, and make a posterior gastro-enterostomy. When the ulcer is on the posterior wall of the first portion of the duodenum and not too adherent to the posterior abdominal wall to permit of freeing the duodenum, he practises the same technic as in large ulcers upon the anterior wall.

When the amputation of the duodenum is made so close to the head

## INDICATIONS FOR MOSETIG-MOORHOF BONE-FILLING

external rotation of the limb. This brings the lesser trochanter well forward, and it should be added to Dr. Ross's flexion with adduction, superlative relaxation thus being obtained by flexion, adduction, and external rotation of the thigh.

In the presence of great separation of the lesser trochanter it may be necessary to cut down, overcome the displacement and retain the lesser trochanter or epiphysis *in situ* by means of a bone-peg. Operative access to the lesser trochanter may be had through the inner portion of the floor of Scarpa's triangle, in the interval between the adductor brevis muscle internally and the pectineus externally, the limb being flexed and rotated outward. The incision should be made along the outer border of the adductor longus muscle as a guide. This interval is free from any important vessels, and the only structure of consequence liable to be injured is the obturator nerve, which may be pushed upward with the handle of the scalpel.

## INDICATIONS FOR THE USE OF MOSETIG-MOORHOF'S IODOFORM WAX BONE-FILLING

DR. ASTLEY P. C. ASHHURST read a paper with the above title, for which see page 227.

DR. GWILYM G. DAVIS thought that many people had been deterred from using this bone wax because of the difficulty of having it retained, and heal in by primary healing. His experience had been the same as that of Dr. Ashhurst, that in cases in which it does not heal in entirely or in which there has been a certain amount of suppuration, it still seems to have a distinctly good effect in hastening the healing process. In many cases it is practically impossible to close the cavity by depressing the skin from the sides and it is especially useful in this class of cases.

DR. EDWARD B. HODGE had used the wax a good deal and had also felt that while it does not always give a primary cure it has never done any harm, and has always helped in a measure. He had also had success in using the bone wax as a secondary dressing, so to speak. If he could not get the cavity dry at the time of the primary operation he would pack the wound, and when at a subsequent dressing it was found dry, fill the bone cavity with the wax.

DR. ASHHURST, in closing, said that he had tried to sterilize the cavity in various ways—hot air blast, radiations from the actual cautery, carbolic acid, iodine. With none of them can one get perfect sterilization when the cavity was primarily infected. Mosetig-Moorhof laid great stress on having the cavity dry. He would use the hot air blast until the shine of the moisture had vanished.

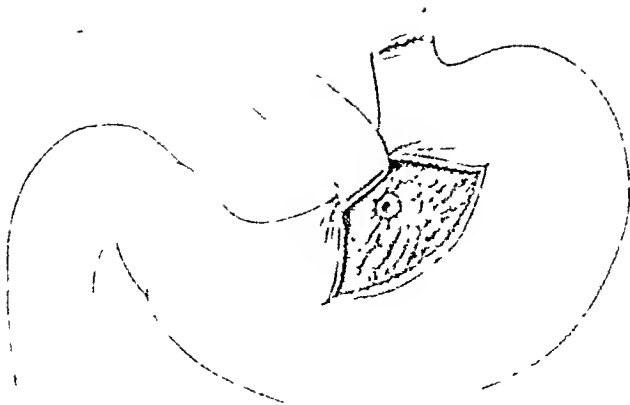


FIG. 5.

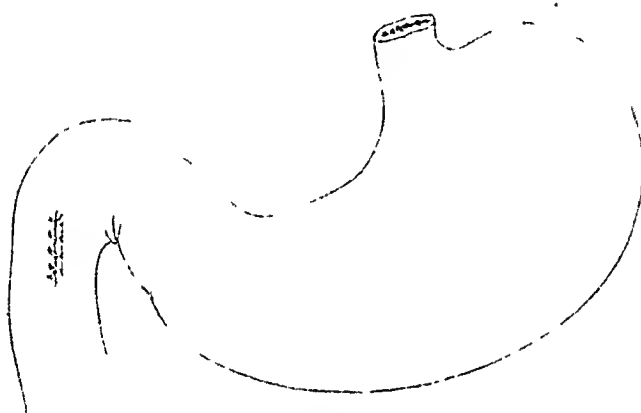


FIG. 6.

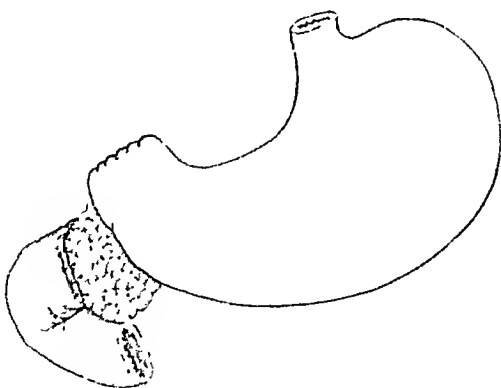


FIG. 7.

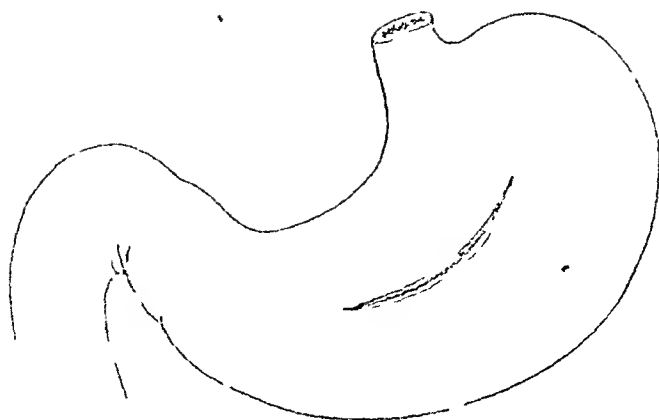


FIG. 2.

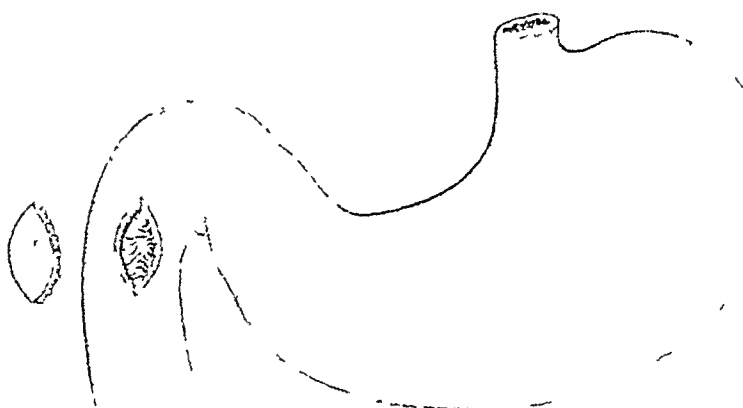


FIG. 3.

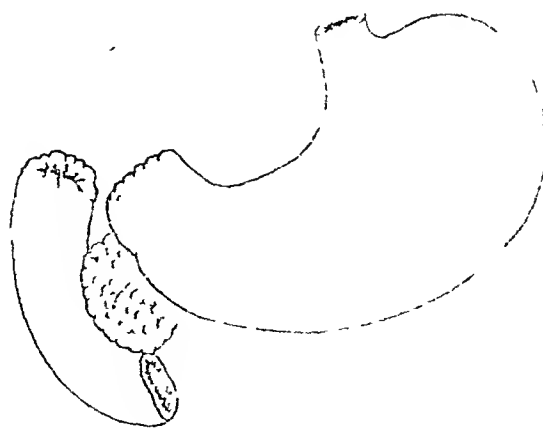


FIG. 4.



FIG. 10.

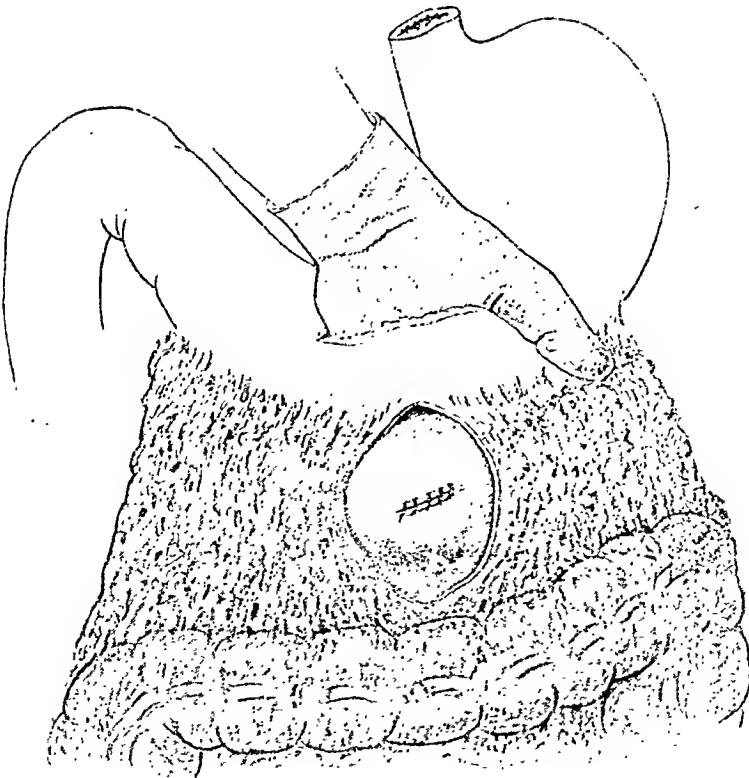


FIG. 11.

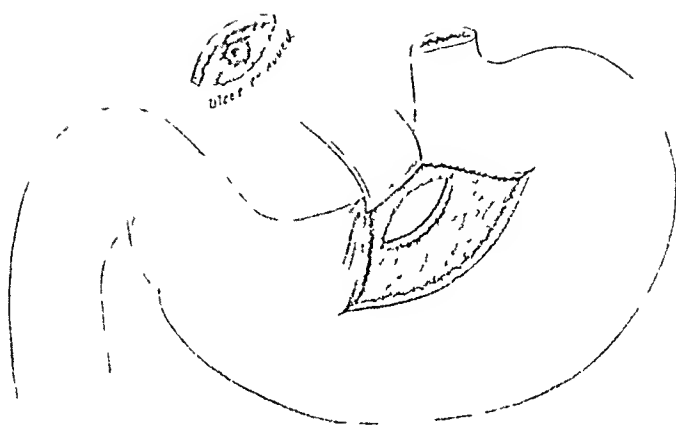


FIG. 8.

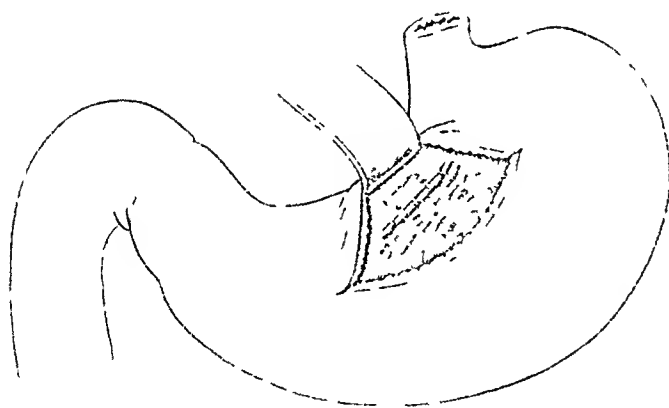


FIG. 9.

of surgical instinct, would attempt such operative work on bruised and distorted tissue, with a profuse blood discharge obscuring the field of operation, the operation being done probably in the middle of the night without proper assistance, implements or light and on the patient's bed. Nevertheless, the majority of the professors of obstetrics in this country advocate the immediate repair of lacerations of the birth canal.

This brought him to another reason for lack of progress in this work. The American specialist in obstetrics is usually the victim of the provincialism, peculiar to this country, of separating the surgical treatment of the diseases of women from obstetrics, so that the teachers of a branch requiring an expert's ability in surgery, have often had no surgical opportunities, training or experience. Consequently, their view on any surgical subject is not authoritative. Finally the surgeons and the so-called though misnamed gynæcologists, who see only the smaller part of the physiology and pathology of womankind, have no knowledge of the nature of the injuries experienced in childbirth and no experience with the result of their surgical repair on subsequent labors.

There are three principles that must govern this work: *First*, the anatomy of the region must be understood; *second*, the operator must know what happens to a woman who is injured in labor, and, *third*, each damaged structure should be restored to its original condition.

It is unnecessary to dwell on the anatomy of the pelvic floor—all are supposed to be familiar with it. It is very necessary in an association like this to point out what happens to the pelvic floor when it is lacerated in parturition. The following is a list of the damage done: (1) The levators are torn loose from their attachments to the pubic and ischial rami, the tear running obliquely inward and downward and not usually involving the whole thickness of the muscle, which is therefore spread out, as it were, and much increased in length and tenuity. (2) The perineal centre is torn through, as a rule, separating the junctions of the superficial and deep transverse perineal muscles and the constrictor vaginæ. (3) The layers of the triangular ligament are torn where they fuse with the perineal centre, leaving a gap through which the rectocele protrudes.

Colles's fascia is naturally torn if the perineal centre is injured. The illustrations presented herewith show each step of the operation for the separate repair of all these structures. By cutting through both layers of the triangular ligament the levator is made accessible above the superior layer, the deep transversus perinæi is exposed between the two. The latter is always retracted and must be fished out of the cavity in which it lies. The posterior column of the

## THE TECHNIC OF PELVIC FLOOR REPAIR

of the pancreas as to preclude the use of the purse-string suture and inversion, he adopted one of two procedures, namely: (1) Dissect the inner wall of the duodenum free from the pancreas (taking care not to injure the common bile-duct), purse-string it, invert and reinforce line of duodenal stump with great omentum, or if this cannot be safely done, (2) close the end of the duodenum with a continuous chromic catgut, stitch and sew the head of the pancreas over the duodenal stump. This he had done in many cases with good results up to the present, except in one instance. The chief point for discussion in the latter technic is the effect that the pancreatic ferments may have upon the transplanted duodenal stump, or, per contra, the possibility that the infection from the duodenal stump may be communicated to the pancreas.

In acute perforation of a duodenal ulcer it is his practice to make a posterior gastro-enterostomy at the primary operation. He had now operated upon forty-six patients in this manner with but one death. His reasons for advocating this procedure are, first, in order to place the ulcerated area immediately at rest; second, to secure the ultimate advantage of the operation which is curative in many cases, and third, because his experience with it has been so satisfactory as to entirely outweigh any theoretical objections that may be made against it.

Posterior gastro-enterostomy when the ulcer is located other than at the pylorus does but little, if any, good, therefore it is a useless procedure from the standpoint of cure. If posterior gastro-enterostomy does any good in this condition, it is only by allowing bile and pancreatic juice to enter the stomach, thus producing a neutralizing effect upon the acid contents of the stomach. That this operation accomplishes good by drainage alone he thought doubtful. The operation accomplishes most good where there is pyloric obstruction and where the ulcer has been excised.

## THE TECHNIC OF PELVIC FLOOR REPAIR

DR. BARTON COOKE HIRST presented a series of drawings, remarking that the poorest work seen in surgical and gynæcological clinics to-day is the repair of the injuries of childbirth in the female genital canal. It is curious that this should be so, for of all the women who consult a physician for something peculiar to their sex, more than half suffer from these injuries and the most frequent of them is the laceration of the pelvic floor.

There are several reasons for this condition of affairs. First and foremost comes the foolish practice of immediate repair. This cannot be done successfully and no surgeon of experience, with the right sort



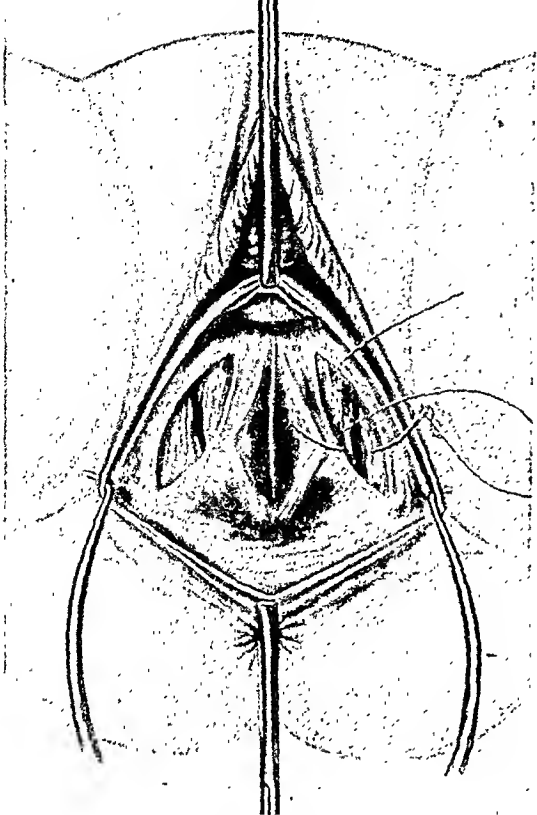


FIG. 16.—The levatores exposed and the cleft in them united by a two-tier suture.

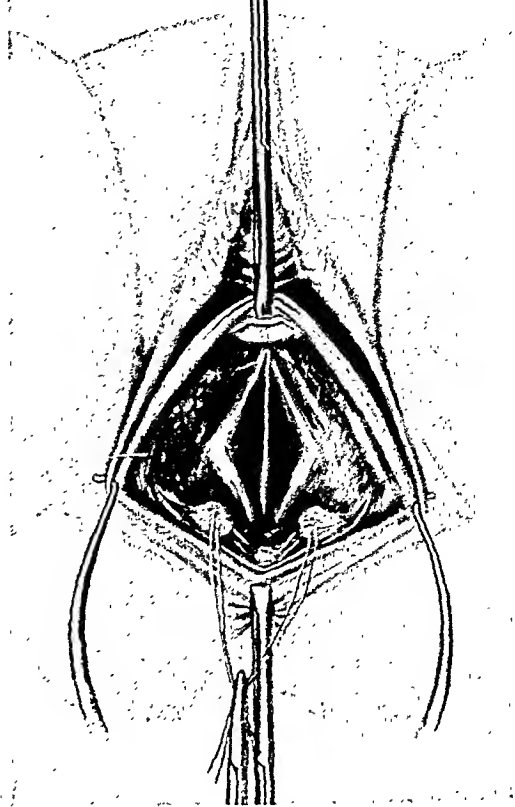


FIG. 17.—The levatores repaired and the deep transversus caught by two sutures and united at the base of the perineal body to give this muscle its original triangular shape and to restore its lifting power on the perineum.

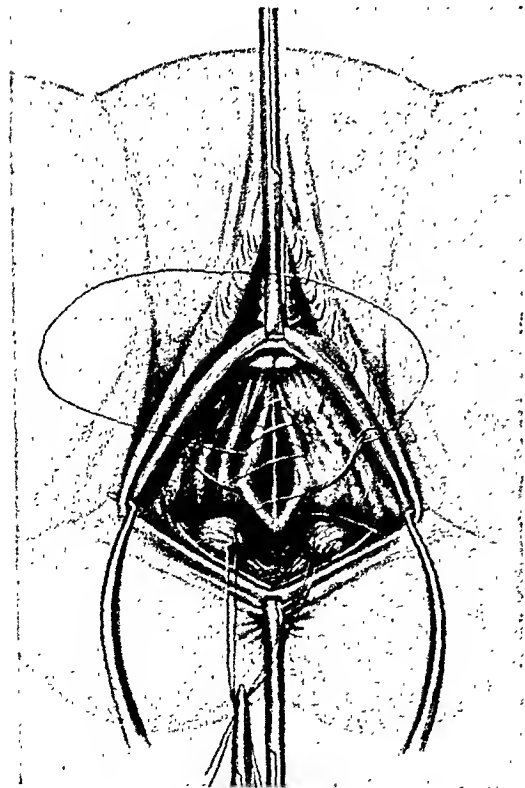


FIG. 18.—The cleft in the central fascia and the fused layers of the triangular ligament closed. It is through this cleft that the rectocele protrudes.

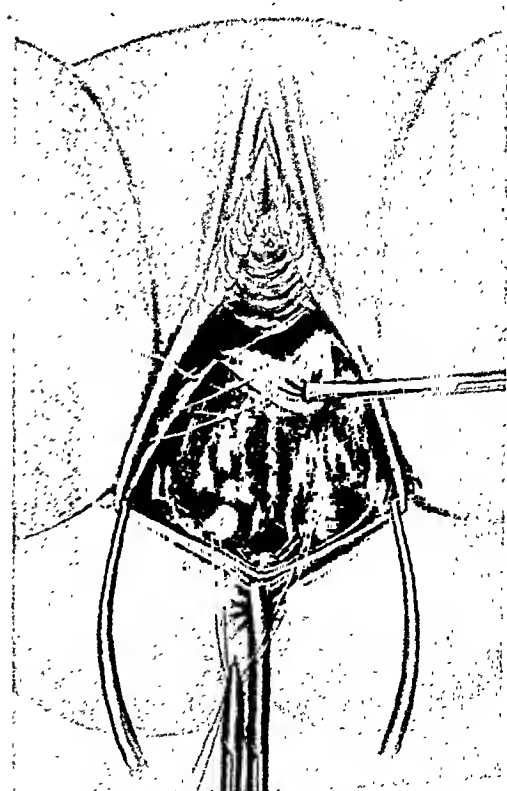


FIG. 19.—The triangular extensions of the denudation in the sulci closed.

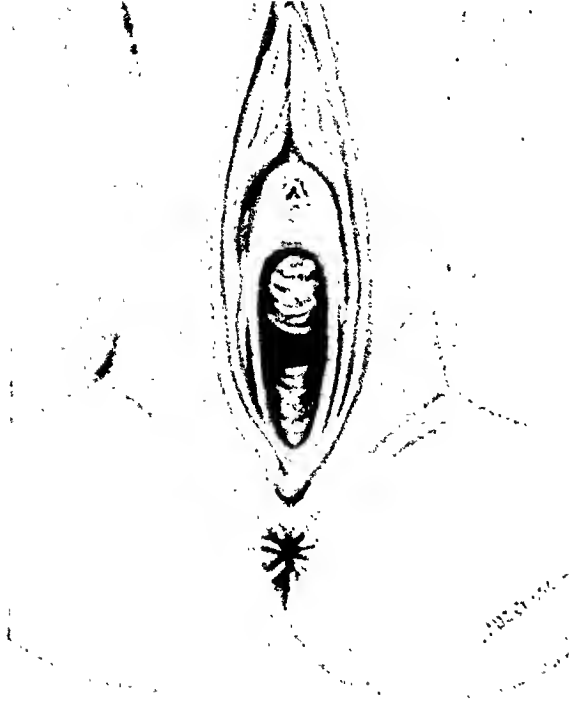


FIG. 12.—The result of laceration of the levatores ani, deep transverse perinei, fused layers of the triangular ligament, perineal centre, junction of superficial transverse perinei and bulbospongiosus muscles and of Colles's fascia. Note the low situation of the anus.

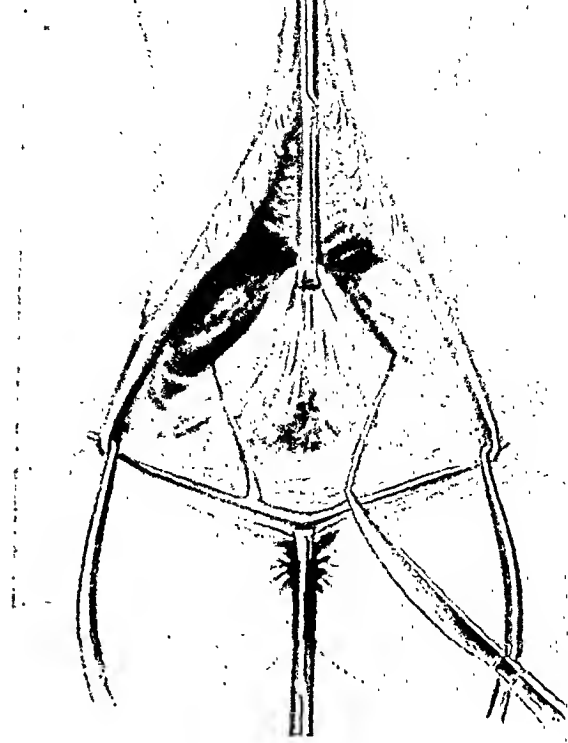


FIG. 13.—A convenient incision for the denudation to expose the injured muscles and fascia.

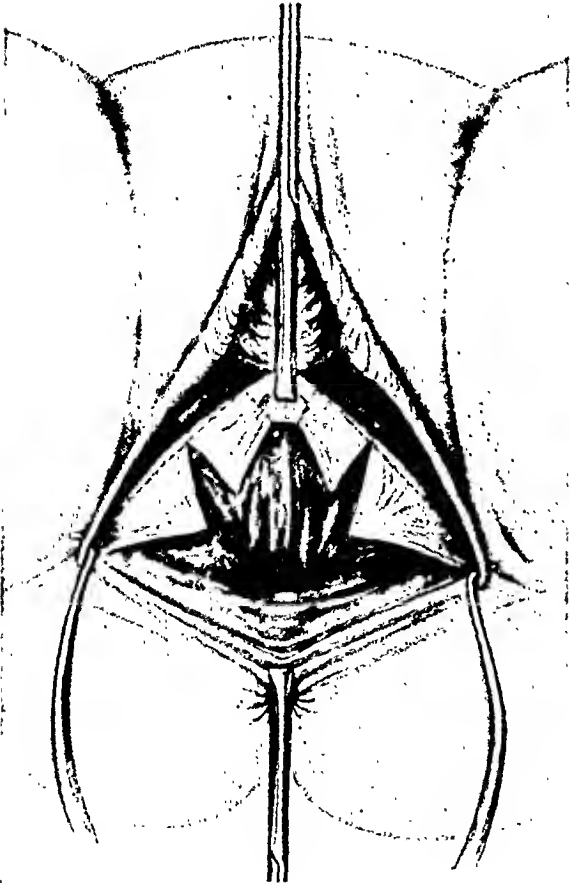


FIG. 14.—The denudation practically accomplished—to be completed by removing the mucous membrane within the dotted lines.

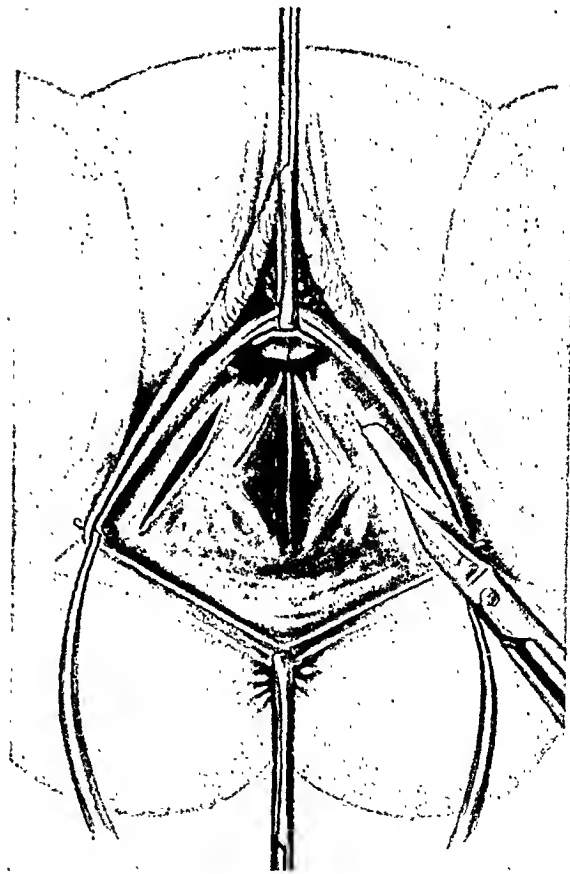


FIG. 15.—The incision through both layers of the triangular ligament to expose the levatores and the transverse perinei profundus.



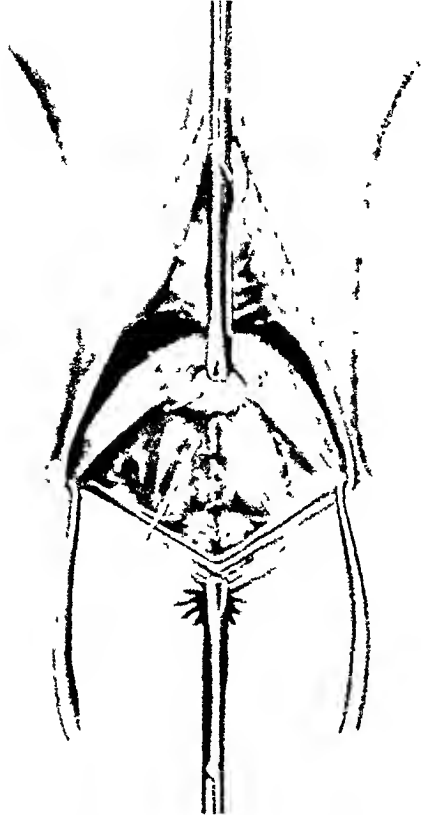


FIG. 20.—The posterior column of the vagina fixed in its normal position.

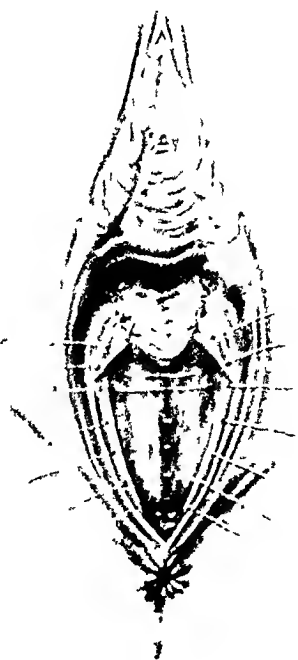


FIG. 21.—The perineal centre and Colles's fascia closed by interrupted sutures.

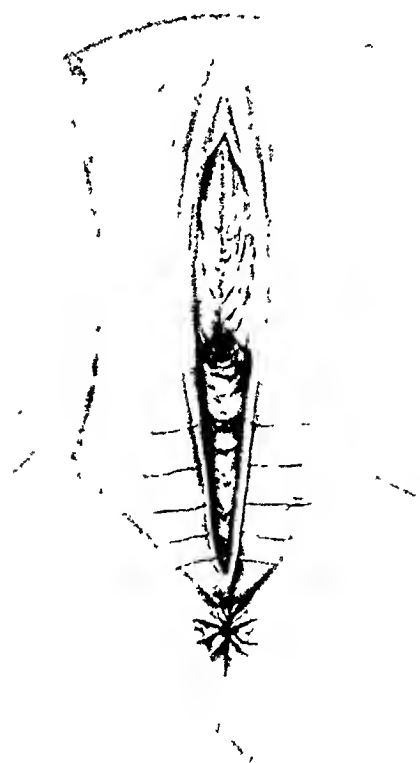


FIG. 22.—The skin of the perineum closed separately, burying all other sutures.

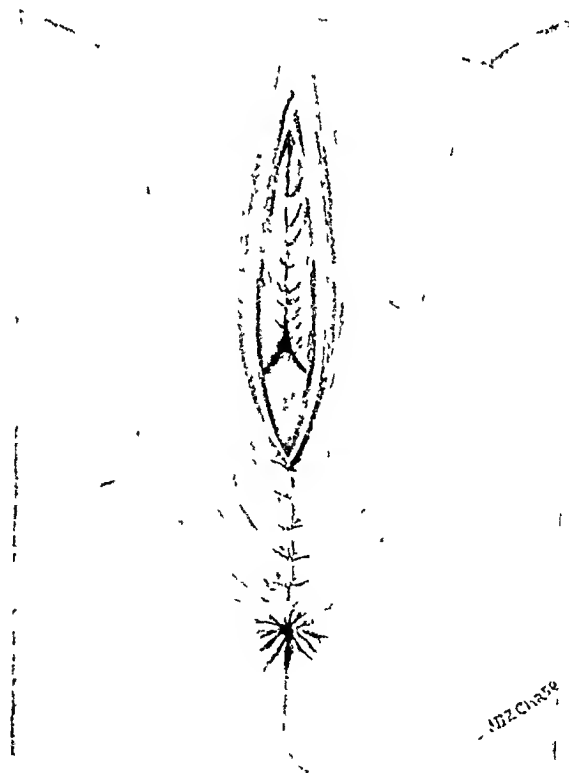


FIG. 23.—The operation concluded. The skin stitches are No 1 extra hard chromic gut. All the other sutures are No 1 chromic gut.

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# TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

*Stated Meeting, Held November 8, 1916*

The President, DR. CHARLES N. DOWD, in the chair

## VOLKMANN'S ISCHÆMIC PARALYSIS

DR. ALFRED S. TAYLOR presented a boy, whose case was described in detail in the paper read by him, for which see *ANNALS OF SURGERY*, January, 1917, p. 28, being the second case.

On June 20, 1911, the boy fractured the lower end of the ulna a short distance above the wrist. The arm was put up within two hours of the time of fracture in wooden splints. They were tied on very firmly, and the doctor put the arm in a sling, and disappeared. Within an hour of the time the splints were put on there was extreme pain, considerable swelling, cyanosis, and blebs on the hand, and within a short time thereafter the boy developed delirium because of the pain, and had some temperature and constitutional disturbance. This was reported to the attending physician, but, with the statement that all fractures were painful, he refused to come and look at the child, and did not come for four days. At the end of that time the splints were removed and it was found that the hand was rigid, there was a slough on the ulna side of the forearm and the wrist, there was a large slough on the flexor aspect of the forearm just below the elbow. It took about three weeks for these infected areas to heal. On the fourth day, when the splint was removed, there was a rigid contracture of the muscles of the forearm. This contracture progressed rapidly until within a short time there was extreme development of the typical Volkmann's ischæmic paralysis.

Nothing was done about the contracture part of the difficulty, the parents being told that this would take care of itself in time, with massage and with the natural use that the child would give to his arm. However, in the middle of August, which would be just about two months from the time of the original injury, the mother noticed, accidentally, that a pin which had happened to stick into the palm of the hand sufficiently to draw blood did not attract the attention of the child to the fact that he had been stuck with the pin. She immediately decided that this represented paralysis, and then insisted that the doctor come and look at it, and also insisted on consultation.

## THE TECHNIC OF PELVIC FLOOR REPAIR

vagina is fixed in its normal position. The same stitches unite the perineal centre and Colles's fascia. The skin is united separately.

DR. RICHARD C. NORRIS said that any one doing much obstetric work will find that in many instances of pelvic floor injury the levator muscles and fascia are separated from their bony attachments. There are, however, many more cases in which the injury is confined to the more central portions of the pelvic floor, the levators being separated from the rectum, and in which separation from the bone has not occurred and which can be primarily repaired with success. It is his practice to do immediate repair of the perineum and the pelvic floor because in a large majority of instances the injury is of the latter type. By careful examination immediately after labor, if the injuries do not extend to the bony attachments, a good result follows from the primary operation. Furthermore, in private practice it is a serious disadvantage to allow an open wound to remain in the vagina for a week or ten days and then to suggest that the patient should undergo an operation with its entailed anxieties, just when the household has recovered its equilibrium and is ready to enjoy the baby's arrival in the home. Practically always one can have the patient do as advised, but sometimes patients resent this to such an extent that they will go to another obstetrician in a second labor. This, of course, is not a justification for doing the wrong thing. The cervix, moreover, when not a source of hemorrhage, if left alone, will often repair itself spontaneously. If repaired too early there may be interference with the discharge from the uterus. Excessive lacerations should be repaired early. His practice was not to delay more than six or eight weeks—at the end of the involution period—and the patient is better satisfied to have this slight operation at this time. The essential point in Dr. Hirst's paper was the need of careful study of the kind of injuries the woman has received. If in these extensive lacerations there has been separation of the fascia from the bony attachments an operation must be devised to meet the conditions. This requires skilled obstetric and gynecologic service. In these excessive lacerations, however skilful the repair, one never can wholly restore the vaginal floor to its original anatomical conditions, and recurrent pregnancies and labors will undo the handiwork of the most skilful gynecologist. In primiparæ with rigid infantile types of vaginas, in which one can foretell these destructive injuries, an extensive so-called episiotomy, in reality a deep incision through the levator muscles and fascia, alongside the rectum, will prevent injuries reaching to bony attachments, and the incision can be satisfactorily repaired immediately after labor.

mann's ischæmic paralysis is that when you come to extend the hand and wrist you get just a little resistance at that angle. He plays violin and he plays piano.

#### TRAUMATIC RUPTURE OF THE BRACHIAL PLEXUS

DR. ALFRED S. TAYLOR presented a man who, in July, 1915, while diving, happened to strike his shoulder on a submerged pipe. When he came to shore again he found that there was absolute loss of power in the right upper extremity, and that there was a very considerable degree of pain in the extremity.

There was found to be a fracture of the clavicle at just about the middle. It healed in a faulty position, with the outer end of the inner fragment depressed downward and backward, presenting a rather ragged edge toward the brachial plexus. Because of the persistent paralysis he saw various consultants, surgeons and neurologists, who advised that he wait for six or eight months to see what would happen by Nature's healing methods. During that time nothing happened in the way of recovery, and finally he came to the Neurological Institute. There was loss of power in the arm, there was a very considerable degree of atrophy, some of which still remains. He could make certain motions with the fingers and slight motions with the wrist; he could not flex the elbow, he could not rotate the arm externally; there was slight power of abduction at the shoulder. An exploratory operation was done on December 21, 1915—that was some five months following the injury. A dissection at the base of the neck demonstrated that the nerve roots coming from the spine were practically normal in appearance, but that, following the roots, underneath the clavicle, they ran into a dense mass of scar tissue. A subperiosteal resection of the clavicle at the site of fracture was done, and the bone ends and the callus all removed. The posterior layer of the periosteum was split in order to expose the nerves which were lying underneath. In doing that, a bundle of nerve was found involved in the periosteum and the scar tissue. That was dissected out carefully. It was followed over and found to be the seventh root which had been distorted from its exit at the spine over to the site of fracture; then it was found to run back, and then down into the axilla. In other words, there were three sharp kinks in the main trunk of the seventh nerve. The fifth and sixth nerves were found to have been torn at a level just about back of the clavicle, and they were the site of dense scar tissue, which would absolutely prevent the passage of any nerve impulses. The eighth cervical and first dorsal nerves were found to be involved in scar tissue and pinched in such way as to prevent physio-

## VOLKMANN'S ISCHÆMIC PARALYSIS

It was on August 16 that the child was taken to a surgeon, who said that it was typical Volkmann's ischæmic paralysis, that nothing would give any promise except resection of both bones, and that even that gave very little promise of a satisfactory result. In other words, following the diagnosis, there was a very bad prognosis given—that no form of treatment would give much promise. This is mentioned merely to indicate that the case looked like one of extremely severe type. When brought to Dr. Taylor shortly after that, he presented a perfectly typical, well-marked ischæmic contracture. There was absolute anesthesia in the ulna nerve area, and there was a very marked hypæsthesia in the median nerve area of the hand. The hand was so rigid that hardly any motion of extension could be brought out on using considerable force, and very little motion in flexion at the wrist. A previous experience with operative interference in these cases had led him to think that operation was perhaps not the best method of procedure; so that he applied, in this case for the first time, the method described in the paper. The brace devised by him was fastened on the forearm, then with a round spool under the fingers, an elastic was led from each end up to the notches above, so that one got a steady, lasting pull and as soon as the muscles yielded at all the elastic would take it up, in that way causing an easy, painless, but persistent extension of the cicatricial tissues. Within four days the parents said that the hand was coming up pretty readily, and within thirteen days it was necessary to change the angle of that brace from about forty-five degrees up to the full ninety. That was on August 29; that was within nine days, you see, the brace having been first applied on August 20. On October 7, when they brought him into town again, the hand was nearly normal in color, it had normal temperature, and the sensation in the ulnar area was almost normal; the sensation in the median area had entirely recovered. In other words, with the stretching of the cicatricial contracture, there had been complete recovery of the function of the ulna and median nerves. The cicatricial mass in the forearm had distinctly softened, he was beginning to get active motion, the interossei muscles, which had been considerably atrophied as well as completely paralyzed, were again resuming their function and had increased somewhat in size.

At the end of December, which was about four months and a half from the time of beginning treatment, the hand and arm were perfectly well—that is, he could do everything that he chose with it, and sensation and color and everything else was perfectly normal.

The boy now can do practically anything with that hand. The only thing which still suggests the fact that he has ever had a Volk-



Dr. Lilienthal then determined to try an arthrodesis of the wrist, which would probably prevent recontracture, while the hand was placed in sufficient extension to permit the flexor tendons to work normally.

On February 24, 1916, he performed this operation in a rather atypical manner. Incision was made at the back of the hand between the little and the ring finger. The wrist was easily exposed but the landmarks were changed on account of the atrophy of the bones. Without regard to anatomy he chiselled out what he thought was the greater part of the mass of carpal bones in one horizontal plane and chiselled off the extreme articular face of the radius, then bringing the two chiselled surfaces together and placing the hand in extension with the fingers flexed around a roller bandage. The hand was also placed in a state of abduction. At the end of the operation he thought that he had denuded the heads of some of the metacarpals and that he had gotten rid of most of the carpal bones. Following a primary union the X-ray demonstrated that the section had gone through the os magnum and unciform, the os magnum being in contact with the end of the radius.

As a result there has been very great improvement, the hand has developed rapidly and the patient is able to do far more than he was able to do before the operation. However, voluntary flexion of the interphalangeal joints is still most defective, probably because of the contraction and atrophy of the bellies of the affected muscle.

The case is presented as exemplifying a new operation—arthrodesis of the wrist for the relief of Volkmann's ischæmic paralysis with contracture. He believed this operation to be much more likely to succeed and to be less dangerous than resection of radius and ulna. In view, however, of what Dr. Taylor has told us, he was convinced that operation should be deferred until it was quite certain that Dr. Taylor's method cannot succeed.

DR. ROYAL WHITMAN presented a boy ten years of age, illustrating a severe type of ischæmic contraction. This was the result of a fracture of the humerus in 1914. He was first seen in June, 1915. There was a typical and resistant contraction of the wrist and fingers, extensive scarring of the flexor surface of the arm and loss of sensation in the fingers and the greater part of the hand.

The correction of the deformity had been accomplished by the Jones method, supplemented by a long incision on the forearm, through which some of the more resistant tissues were elongated and the compression of the fascia relieved.

The patient had not been seen for a year, although according to

## TRAUMATIC RUPTURE OF BRACHIAL PLEXUS

logical function, but they evidently had not been otherwise damaged. Therefore, the fifth and sixth were resected until one got good nerve bundles above and below; and the seventh, where it had been seriously damaged in part of its course, was also resected; and then was done an end-to-end anastomosis between the ends of these nerves. About two and a half centimetres or an inch of nerve tissue with scar was excised.

It was interesting that the second day after the operation, sensation in the ulnar side of the hand had returned. Preceding that time it had been numb. In other words, the eighth cervical and first dorsal, having been pinched by scar tissue only, had resumed function two days from the time of their release from scar pressure. On the fifth day he for the first time was able to use his interossei muscles, they also being controlled by these same two roots.

From that time there has been steady progress to recovery. He has been quite faithful to his massage and electricity and all the other methods of physical therapeutics advised. He is a mechanical engineer, and he has gotten now so that he can again use his pencil for drawing and writing and things of that sort. In other words, he has now recovered motion in every single one of the muscles of that extremity. The full range of motion is not yet there, and of course there is still a great deal lacking in power.

DR. HOWARD LILIENTHAL presented a boy who was admitted to Mt. Sinai Hospital on April 27, 1907, five and a half months following a fracture of the elbow with resulting ischaemic paralysis, with the characteristic infantile hand, hyperidrosis, etc. On April 29 a well padded dorsal splint was put on for four hours and then removed. A beginning skin necrosis was found at the back of the wrist, so this method of treatment had to be abandoned. On May 24, 1907, he resected the radius and ulna, inserting an Elsberg intermedullary aluminium splint into the radius. The ulna came together nicely without splint or plate. For complete report see ANNALS OF SURGERY reference in Dr. Taylor's bibliography.

There was some immediate improvement, and a number of months later the hand showed less sweating and seemed somewhat improved, but there was not as much gain as had been hoped for. A few years later he returned with his Volkmann's paralysis as bad as ever, the contracture having recurred. A piece of muscle taken out at the time of the first operation showed interstitial myositis with atrophy. This patient was transferred to the physiotherapy department of Mt. Sinai Hospital and Dr. Wolf, chief of the department, stated that he could not do anything for him.

did he know of any method of telling beforehand whether this will subsequently happen.

The parents agreed to the operation, so on September 14, 1916, the child was placed prone on a hot water bottle and a few drops of ether were administered. For two days prior to the operation a weak green soap poultice had been applied to the ulcerated area. A probe was inserted through the opening in the sac upwards and the tissues were found to be very thin. These were split vertically upwards. The opening in the neck of the sac was no larger than the blunt end of a lead pencil. Externally two elliptical incisions were made between the lateral skin and muscles and the sac which was dissected free down to the neck. On one side what looked like a good sized nerve was preserved, the remainder of the sac was cut away, the nerve was reduced through the opening in the neck and the sac edges were sewn together, closing the neck. Two small flaps were fashioned from the immediate tissues on the sides and were brought together edge to edge and sutured with plain catgut. Two larger flaps were then made, hinged internally, out of the vertebral aponeuroses on the sides. These were turned inwardly one upon the other and were sutured with mattress chromic catgut interrupted sutures, as in an umbilical hernia operation. The edge of the more superficial flap was then sutured to the tissues on the side with chromic catgut. The indurated edges of the skin were trimmed away. It was necessary to undermine the skin edges extensively before they could be brought together without tension. Silk-worm gut sutures were used. There was no drainage of the wound. The convalescence was uneventful. The wound did not suppurate and there was no evidence of meningitis. The skin edges of the wound separated and it was too weeks before it was tightly healed. The child left the hospital in excellent condition. On returning, three weeks later, it was discovered that the fontanelles were beginning to bulge. Now there is well marked hydrocephalus. Suggestions from the members as to the best method of treating this condition would be welcome.

DR. ALFRED S. TAYLOR said that the statements in the books that operation on spina bifida causes hydrocephalus ought not to be taken too seriously. A spina bifida and hydrocephalus are things which are apt to occur in the same child from the same abnormality in development, and the mere closure of a little sac the size of a hen's egg could have nothing to do with the development of hydrocephalus. As a rule the spina bifida is present at birth, and hydrocephalus usually begins three or four months after birth. If the spina bifida is operated the operation has no relation to the development of hydrocephalus—

the mother, massage and stretching begun at the hospital had been carried out during the interval. The deformity had in some degree recurred, but the improvement had been marked. Sensation had returned in the little finger, and the interossei are active. It would appear that further corrective treatment might now be undertaken with advantage.

This case was one of five under observation at the Hospital in 1915. One was easily corrected by mechanical means, the four others were of the most resistant form, in one of which a resection of the bones of the forearm had been performed previously in another hospital without effect. These were treated as described.

#### SPINA BIFIDA: POST-OPERATIVE HYDROCEPHALUS

DR. CLARENCE A. McWILLIAMS presented a boy baby, two weeks old on admission, who was normally born at term and was breast fed up to time of admission. Mother and father both well, also one other child now two years old. The parents noticed a sore on the lower part of the back at birth and also double club feet. On examination of the back there was seen over the lower lumbar and sacral regions a pear-shaped ulcer 6 x 4 cm., irregular and covered with sloughs and with reddened skin about it. There was a thin yellowish discharge on its surface. In the lower posture of this area there was a small, slightly bulging, blister-like area, about 2 mm. in diameter, which looked like a thin membrane over clear fluid. No spinal fluid was seen. The edges of the ulcer were raised, red and indurated. A wet dressing was applied for several days to the ulcer. The child's head was normal and there was no evidence of hydrocephalus. There was double talipes equinovarus. The child did not move the legs or feet and could not be made to cry out on sticking a pin into either foot or leg. The sphincters were not thought to be involved because there was no continuous discharge from anus or penis. After several days the sac ruptured and thereafter there was a more or less continuous discharge of spinal fluid through an opening, the size of a knitting needle, in the lower part of the ulcerated area.

The outlook for the child seemed desperate either with or without operation. A certain small proportion of such patients have been found to be paralyzed owing to the pressure of the distended sac upon the nerve filaments, relief of this pressure improving the paralysis. Rupture of the sac had removed this pressure but this exposed the child continuously to the danger of infection of the sac and spinal membranes. He did not know what proportion of such patients develop hydrocephalus as the result of the successful closure of the sac, neither





FIG. 1.—Before operation.

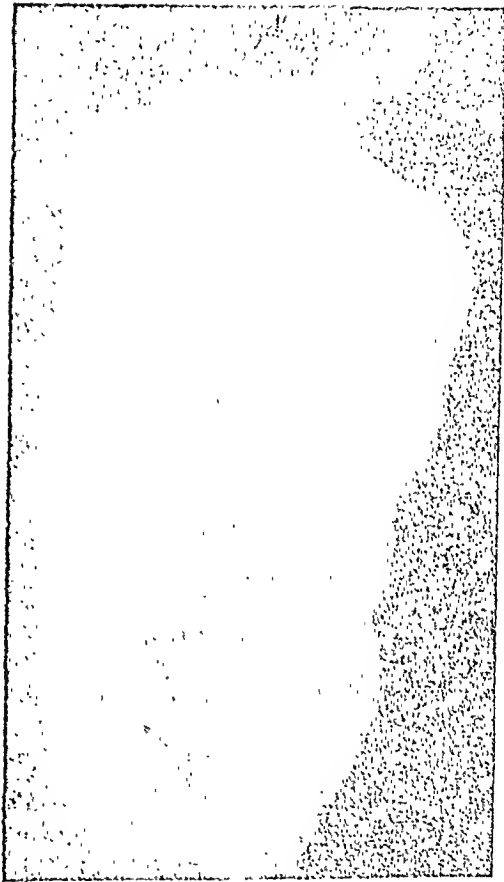


FIG. 2.—A month and a half after operation.

## LATE RESULT OF SPLENECTOMY FOR VON JAKSCH'S ANÆMIA

DR. E. H. POOL presented the same child who was shown at a meeting of the Society in October, 1915. The spleen was removed eighteen months ago for von Jaksch's anæmia: she was then in extremely bad condition; splenectomy improved her condition rapidly. Dr. Pool presented her again to demonstrate that the improvement following the splenectomy had been lasting.

The child was admitted to the New York Hospital with a moderate grade of rickets; anæmia, and enlargement of spleen. The details were given in the former presentation before this Society October 13, 1915. (*ANNALS OF SURGERY*, Vol. lxiii, Jan., 1916, p. 122.) After considerable study and treatment her spleen was removed on May 1, 1915. No transfusion was made. Immediately she began to show improvement. During the three weeks after the operation her red cells rose from 2,700,000 to 4,500,000 and hæmoglobin from 45 to 60 per cent.

The diagnosis of von Jaksch's anæmia was based on the well-marked anæmia, leucocyte count and large spleen associated with rickets in an infant. Histological examination of the spleen confirmed the diagnosis. The spleen showed extreme grade of myeloidization of the pulp with atrophy of the Malpighian bodies.

This case can properly be considered as belonging to the group known as infantile pseudo-leukæmia described by von Jaksch. Following her splenectomy she improved and has continued her improvement for a period of eighteen months, and is now apparently in good health. There is still the same striking change in the blood picture which was noted in the last report, namely, the percentage of mononuclear cells is much higher than one would expect.

Blood examination October 20, 1916; hæmoglobin 94, per cent.; R. B. C. 5,632,000; W. B. C. 15,000; polymorphonuclears 21 per cent.; small mononuclears 72 per cent.; large mononuclears 7 per cent. (Fig. 3).

## NEPHROLITHIASIS AND PYONEPHROSIS IN CHILD

DR. E. H. POOL showed a boy aged four, who was admitted to the New York Hospital, Medical Service, with diagnosis of sarcoma of right kidney. The child had a very large abdomen, was weak, anæmic, and losing weight. X-rays (Fig. 4) showed a much enlarged right kidney with small calculus and a large stone in left kidney. There was pus in the urine. Temp. 99 to 101, W. B. C. 11,500, R. B. C. 3,520,000, Hb. 35 per cent. Wassermann negative. Von Pirquet: very faint. Moro: negative.

that it will develop because of the operation. In a large number of these cases hydrocephalus occurs when nothing has been done to spina bifida, so that the two perhaps result from the same cause, but that the one does not aggravate the other.

DR. ARTHUR L. FISK said that he operated, over nine years ago, on a case of spina bifida similar to the case shown by Dr. McWilliams. The patient had been seen by him two weeks ago, and she has no hydrocephalus. He had observed hydrocephalus occur after operations for the cure of meningocele, or spina bifida high up in the spinal column.

DR. CHARLES N. DOWD stated that in an infant, upon whom he had successfully operated for spina bifida in 1915, a moderate degree of hydrocephalus had developed by the end of a year.

DR. CHARLES A. ELSBERG said that for a number of years he had hesitated to operate on patients with spina bifida if there was a hydrocephalus. Since we have the operation of puncture of the corpus callosum, in which a communication is made between the ventricles and the subarachnoid space over the convexity, he had operated on quite a number of these patients who have hydrocephalus. He usually first tests the absorptive power of the subarachnoid space and learns whether there is an obstructive hydrocephalus, by means of neutral phenolphthalein injected into the subarachnoid space and into the ventricle. Having determined the kind of hydrocephalus, he first punctures the corpus callosum and follows it by the spina bifida operation. Recently he had not a single instance of rapid increase of the hydrocephalus after this procedure.

DR. LAMBERT agreed with Dr. Taylor that the two conditions—hydrocephalus and spina bifida—often accompany one another, and it is very questionable whether the closure of the small sac of the spina bifida necessarily results in, and gives rise to, the hydrocephalus. His experience, however, did not entirely agree with that of Dr. Elsberg in regard to the phenolsulphophthalein test as a measure of the absorptive power of the subarachnoid space. It only establishes the fact that the absorptive power from the subarachnoid space is normal in regard to the drug, but is no indication as to whether it is able to absorb the amount of cerebral spinal fluid which is secreted, and with the non-obstructive form of hydrocephalus present—that is the hydrocephalus of the communicating type—it is in no sense a sure indication as to whether the closure of the spina bifida will, or will not, be followed by the development of a hydrocephalus. In the obstructive form of hydrocephalus the corpus callosum puncture has been a successful procedure for a short space of time, but in my hands has not given permanently brilliant results.







FIG. 3.—Von Jaksch's anemia; splenectomy; present condition.



FIG. 4.—Nephrolithiasis and pyonephrosis in a child. Skiagram before operation.

The child picked up a bit and then started down hill again. A transfusion of 120 c.c. by Lindemann method was given March 28, 1915; mother as donor. Child always rallied wonderfully after the transfusions. Patient continued to improve and urinary discharge in left flank stopped. Child became septic and very anæmic. On May 27, 1916, a transfusion by Lindemann method was done, 235 c.c. of blood given from mother and then a right nephrectomy performed. Pathological report, pyonephrosis.

Patient slowly recovered. The wound healed after considerable sloughing and patient was discharged July 25, 1916. At that time he was up and about, cheerful, temp. normal. He has continued to improve, and is now in good health. Hæmoglobin 65 per cent.; R. B. C. 3,100,000; W. B. C. 6500; weight 28 lbs. Urine, acid, clear, trace of albumin. Few white blood cells, rare hyaline cast.

#### MULTIPLE URETERAL CALCULI AND PYONEPHROSIS

Dr. E. H. Pool presented a man, aged twenty-eight years, who was admitted to New York Hospital on May 12, 1916, complaining of pain in left side and slight pain on urination.

Illness began six weeks before admission with pain in the left side intermittent in character. The pain was experienced only in the left upper quadrant; anteriorly and posteriorly. It did not radiate to the groin or elsewhere. Occasionally there was pain on urination. A heavy urinary sediment had been noticed. The physical examination was practically negative save for the surgical condition. There was tenderness in left flank, and a large, hard, slightly movable tender mass was felt deeply in left flank. Urinalysis showed large amount of pus.

Patient was studied in Medical Ward by Dr. Wm. Williams. X-ray showed a very unusual condition, that is a group of shadows which were interpreted as an accumulation of calculi in lower ureter (Fig. 5).

Cystoscopic examination by Dr. Bancroft: Right side normal. Left ureteral orifice projects from trigone like a nipple 1 cm. Impossible to enter even finest catheter. Right kidney functioning normally.

On May 20, 1916, nephrectomy for pyonephrosis and ureterectomy for stones in ureter. An oblique incision exposed an enormous kidney which consisted of a thin shell and many loculi. It was ruptured in separating and contained foul-smelling pus. Kidney was delivered. The distended ureter was approximately two inches in diameter. The vessels of the pedicle were ligated and cut and the ureter dissected downward about six inches. The ureter distended with pus was opened and the pus removed by aspiration; its wall was extremely thick. Probe passed down but could neither feel the stones nor enter the

## NEPHROLITHIASIS AND PYONEPHROSIS IN CHILD

Operation was deferred for the following reasons: He was an extremely bad risk; both kidneys presented lesions; diagnosis uncertain; if malignant growth, operation not indicated; if inflammatory, he might be improved, diagnosis established and proper operative procedure undertaken.

Patient's condition grew worse. A diagnosis of right pyonephrosis was made by Dr. Wm. Williams and on December 11, 1915, the kidney was explored, found to be enormous and contained pus. It was drained. Patient was in very poor condition and nephrectomy did not seem warranted. He did not improve; urine contained pus. Patient seemed gradually going down hill and was septic. It was recognized that the pus kidney must come out, but there was a serious difficulty. The other kidney (the left) was enlarged and showed a large stone by X-ray; and it was considered probable that this kidney also contained pus. It too would eventually have to be operated upon. It seemed possible that there was some functioning tissue in the right kidney. It was thought advisable to conserve this tissue until the effect of operation on the left had been noted. It was therefore decided to operate upon the left kidney first, remove the stone, and later to do a right nephrectomy, when the function of the left kidney had become re-established.

Accordingly, on February 18, 1916, the child, in an extremely weakened condition, was brought to the operating room, and a transfusion of 220 c.c. made under local anæsthesia by Lindemann method, the mother acting as donor. The left kidney was then operated upon. It looked like a normal adult kidney. There were no visible inflammatory changes. The pelvic wall, which was thick and œdematous, was opened in the hope of being able to extract the stone without damage to the kidney itself. The stone could not be delivered without risk of tearing the pelvis across. Accordingly, while grasping the stone in a small sponge stick through the pelvic opening, the stone was pressed upward toward the cortex and an incision made through the cortex following the bloodless line. Very little bleeding occurred, and the stone was readily removed. Two transfixion stitches of plain gut placed through the kidney to approximate cut surfaces and the cut edges were overhanded with continuous plain catgut. The opening in the pelvis was then closed with fine chromic sutures, not penetrating the mucous membrane. A piece of fatty capsule was sutured over this and a cigarette drain tied to the flap of fatty capsule which came between the drain and the suture line in the pelvis. Patient voided urine for five days, then ceased voiding for twelve days, but discharged urine freely from left flank.





FIG. 5.—*a*, X-ray of ureter; *b*, photograph of calculi after removal.

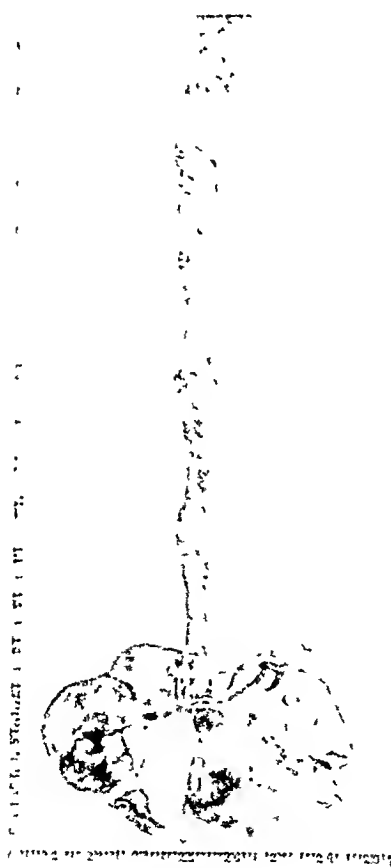


FIG. 6.—Case III. Kidney and ureter removed together.

the region of the scar. The left kidney was not palpable. When the patient sat or stood up the discharge from the sinus tract was increased. The amount of urine passed per day through the urethra varied from 16 to 32 ounces. Urine analysis showed numerous pus cells and a persistently turbid urine.

*Operation* (February 14, 1916).—For closure of the urinary fistula. Through a midline incision, the peritoneal cavity was opened and the bladder was found firmly adherent to the anterior abdominal wall on the left side. The bladder was opened during the separation of adhesions. A finger introduced through this opening into the bladder and passed to the left entered the bladder saccule which was adherent just behind the old hernial wound. The bladder was freed by cutting frankly across this artificial diverticulum. The two openings in the bladder were then connected and the bladder closed with a row of continuous chromic gut sutures, not passing through the mucous membrane. A second row of interrupted chromic gut sutures was then passed through the first row of sutures. A sound was then passed through the severed distal portion of the sinus and palpated from without, above the anterior superior spine. At this point an incision was made down through the peritoneum, the small portion of the bladder wall remaining being covered by folding the peritoneum over it. The retroperitoneal space thus made was drained by a split rubber tube inserted through the flank.

*Cystoscopic Examination*.—By Dr. MacKenzie, February 8, 1916. "There was a large opening in the bladder in the left wall above the ureteral opening. Through this opening a ureteral catheter was easily passed into the inguinal wound and out through the sinus opening. Both ureters were easily catheterized to the pelvis of the kidney. There was a slight ulceration on the bladder wall near the opening of the sinus into the bladder. Urine from each ureter was clear. Both ureters were working in normal manner."

For some time after the operation urotropin was administered. A permanent catheter was inserted by the urethra, with a daily irrigation of the bladder with boric acid. There was some slight discharge of serosanguinous fluid from both wounds for a number of days. One week after operation he began to have a copious discharge from the abdominal wound. On this day the permanent catheter in the urethra was removed. Two weeks and a half after operation he voided a small quantity and three weeks after the operation his daily voidance was ten ounces. The suprapubic discharge gradually diminished. The wound in the flank healed completely two weeks after operation.

## PARTIAL EXCISION OF BLADDER

bladder. A large rubber tube was passed down through the opening in the ureter and left in place. The patient was then turned on his back, the abdomen having been prepared before the operation, and an incision 3 inches long was made 1 inch above Poupart's. External oblique split. Internal oblique and transversalis separated close to Poupart's and the peritoneum reached and dissected mesially until the ureter containing tube was felt. The ureter was drawn out of the wound and dissected bluntly and without much difficulty upward and downward. Stones could not be felt, however, and an opening was made in the ureter and stone forceps passed down and twelve stones removed which corresponded in size and number to those in the X-ray. The reason the stones could not be felt with the probe which had been passed down from above was that the ureter made a bend just above the stones, which prevented the passage of the probe into the stone-bearing pouch. The ureter was ligated as close as possible to the bladder and cut off, the mucous membrane outside of the ligature being cauterized. Two rubber dams inserted in this wound and two silkworm stitches. Patient turned on side and kidney and ureter removed together *en masse* without difficulty (Fig. 6).

Patient had a smooth convalescence. Was discharged in thirty-one days.

Patient returned to hospital for observation four months after the operation. His general health was good; no complaint; both wounds solid with good muscle union. Exam. of urine negative; no pus.

## PARTIAL EXCISION OF THE BLADDER FOR URINARY FISTULA COMPLICATING A PREVIOUS INGUINAL HERNIOTOMY

DR. BURTON J. LEE presented a man thirty years of age, who was admitted to New York Hospital in the service of Dr. Charles L. Gibson, February 7, 1916. His chief complaint was a discharge of urine as the result of a left inguinal herniotomy, performed for recurrent hernia about four weeks before at another hospital. There had been no leakage of urine for three weeks and three days following the herniotomy. Since then there had been a steady discharge of urine, accompanied by some left lumbar pain, dull in character, but constant. Patient stated that upon pressure over the left flank and inguinal region, the watery discharge from the sinus tract was increased.

Examination revealed a poorly developed and poorly nourished man who looked rather ill. There were scars in both inguinal regions. At about the middle of the left inguinal scar there was a discharge of fluid of the appearance and odor of urine. Over the left lumbar region, there was considerable rigidity which extended downward to



DR. ALEXIS V. MOSCHCOWITZ called attention to the fact that the time of the occurrence of a urinary leakage after an operation for the radical cure of an inguinal hernia is very important. There are two methods in which such urinary leakage occurs. One way is to perforate the bladder with a needle, when sewing up the neck of the sac, or when placing the deep sutures; in these cases the urinary leakage occurs very early. The second is by tying off a small portion of the bladder; with subsequent sloughing off; in these cases the urinary leakage occurs very late.

Dr. Moschcowitz also fully agrees with Dr. Downes as regards the importance of properly separating the peritoneal sac from the bladder. He also exposes fully the bladder in all direct herniæ, and also in all larger oblique forms.

He isolates the peritoneum until the obliterated hypogastric artery is exposed; when this is exposed, and the neck of the sac is sutured or ligated at his point, it appears to him that all chances of injuring the bladder, and of a recurrence of the hernia on account of a remaining peritoneal diverticulum have been obviated.

DR. WILLIAM B. COLEY thought more heed should be paid to the properitoneal fat, which is usually a danger signal. If this were done one would avoid most injuries of the bladder. He had often spoken of it, and had himself always used great care when he had reached this thick layer of fat, not to go any further, particularly in dissecting the sac higher up or in tying off the sac. Most wounds are caused by tying the sac too high up, or in perforating with a needle. They had never met with this accident at the Hospital for Ruptured and Crippled, where over five thousand operations for hernia have been performed.

DR. NATHANIEL W. GREEN thought that a good many men make hernial repairs with rather a nebulous idea of the anatomy near the median line. They push up a certain amount of the fat towards the middle line, especially in direct hernias and in large indirect hernias; but they do not know exactly what they are doing. He had had the good luck to watch Dr. Downes in many of his hernias and the thing has cleared itself up to him very much. The procedure which he uses is to put his finger in and pull the peritoneum up tightly outward over his finger. He then pushes the bladder towards the middle line by blunt dissection, and that gets the bladder out of the way. He then opens the peritoneum downward and inward as if it were a peritoneal wound of longer dimension and starts and sews it over, and then draws it up. This procedure has cleared up the question of the bladder in the hernia wounds.

## PARTIAL EXCISION OF BLADDER

Upon his discharge from the hospital, March 18, he was in very good general condition and was voiding normally. Save for a brief interval some months ago, when there was a discharge of urine for several days, there has been no leakage from the suprapubic wound.

*Cystoscopic Examination:* November 2, 1916, by Dr. McNeill. "Cystoscope passed easily; urethra normal. Bladder mucous membrane normal except at the fundus of the bladder a little to the left of the median line, where a small scar is seen which is smooth and causes no puckering of mucous membrane and no diverticulum. Capacity of the bladder is 29 ounces. Trigone normal; ureteral openings normal in position, contour and shape; easily catheterized and urine collected from both clear."

The man has a moderate sized ventral hernia, for which he is wearing a belt, but he has refused further surgical treatment.

In a cursory review of the literature upon bladder wounds during herniotomy, one finds that in 1895, in the *ANNALS OF SURGERY*, Dr. B. Farquhar Curtis reported a considerable number of cases. Dr. Charles L. Gibson, in the *Medical Record*, March 18, 1897, added further cases, making a total of 103 cases studied, of which twenty-two were femoral. There was a mortality of 12 per cent. in this series of cases. The most recent contribution upon this subject was by Dr. W. B. DeGarino, in the *New York State Medical Journal*, in 1913. He covered the subject very extensively and completed the literature up to the date of his publication. He summarized the various factors which would lead one to suspect the presence of the bladder in close proximity to the hernial sac as—the large veins present, the lighter yellow color of the fat, the difficulty with which the fat separates from the sac and the presence of a second, entirely free sac on the inner side of the cord.

This case was presented that it might be placed on record, and to call attention again to the possibility of this complication during herniotomy.

DR. WILLIAM A. DOWNES wondered that the accident Dr. Lee referred to does not happen a great deal more often than it does. If surgeons made a rule to expose the bladder in all direct hernias and in all large indirect hernias, by a sufficient dissection, they would be able to close their hernias much more satisfactorily to themselves and without the feeling that when they passed a suture around the neck of the sac that they may be injuring the bladder. The bladder can be exposed without the slightest difficulty in practically every case—and should be.

interrupted catgut. Closure without drainage. Through-and-through sutures of silkworm gut.

*Pathological Report.*—By Dr. William Elser. Specimen consisted of a section of large intestine 9 cm. in length. The wall of the intestine was for the greater part thickened to about  $2\frac{1}{2}$  cm. by a hard mass attached to and incorporated in the peritoneal coat. This mass had been seared, incised from the peritoneal side, and these operations have so altered the tissues that a further gross analysis of the condition is rendered impossible. Microscopical examination showed the lesions of a productive inflammatory process. In places there was a leucocytic infiltration. A few giant cells were also found surrounding foreign bodies. It was impossible to determine the exact nature of the substances which gave rise to the formation of the foreign body giant cells, but they were not cotton, linen or silk threads. The central part of this mass contained pus which was not saved. The organism recovered from the material (wall of abscess) was a *staphylococcus pyogenes aureus*.

At the time of operation it was readily seen that the tumor mass did not involve the mucous membrane of the transverse colon. There was some infection of the wound which gradually lessened, with fecal discharge for about three weeks after the operation, and a persistent sinus tract for about three months. Since then the wound has remained healed.

The man has a ventral hernia, for which he refuses surgical treatment, and at times suffers somewhat from general abdominal cramps. His general condition is fair.

It is interesting to consider the possible source for this inflammatory tumor, for some infective organism may have been introduced at the time of operation, initiating the inflammatory focus. There is, of course, a possibility that this inflammatory mass in the transverse colon was present at the time the original appendectomy was done, but no proof concerning this is at hand. The resemblance of the mass to a malignant new growth, because of its firmness and infiltrating qualities and the non-involvement of the mucous membrane were additional interesting features.

The case is unique in the writer's experience and seemed worthy, therefore, of report.

#### DECOMPRESSIVE LAMINECTOMY FOR MULTIPLE SCLEROSIS

DR. CHAS. A. ELSBERG presented a man thirty years of age, who noticed about a year before that he was losing control of his bladder and that he was becoming constipated. Several months later he began

## PARTIAL RESECTION OF TRANSVERSE COLON

### PARTIAL RESECTION OF THE TRANSVERSE COLON FOR NON-MALIGNANT INFLAMMATORY TUMOR

DR. BURTON J. LEE presented a man, thirty-two years of age, who was admitted to New York Hospital, in the service of Dr. Charles L. Gibson, April 1, 1916. The patient had a history of chronic indigestion for about a year and a half, with increased symptoms during the last four weeks. His chief complaints were a feeling of distention in the epigastrium and of belching of gas with fairly marked constipation. Examination at that time revealed tenderness over the right lumbar region on deep pressure. There was less tenderness over the upper and middle portions of the right abdomen. No mass palpable. Physical otherwise negative. The operation was performed April 4, 1916, a right paramedian incision being used, the rectus being pulled outward. The appendix was readily delivered and was found atrophic, long and sharply kinked at the junction of the middle and proximal two-thirds—the gross lesion being therefore one of chronic appendicitis. No microscopic examination of the appendix was made. Appendectomy with cautery and inversion of stump. First purse-string Pagenstecher; second chromic catgut. Other organs apparently normal. Wound closed in tiers without drainage. The patient had an uneventful recovery and left the hospital at the end of two weeks.

He returned on April 29, his chief complaint at this time being pain in the epigastrium and rather obstinate constipation. For four days previous to admission he had had very severe cramps and there had been no movements of the bowels. Examination at this time showed a well nourished man, not looking acutely ill. Upon palpation of the abdomen, there was a distinct and rather hard mass to be felt, low down on the left side of the epigastrium. He was not especially tender upon pressure.

The abdomen was reopened May 6, 1916. Median incision above the umbilicus, all layers of the abdominal wall excepting the skin were incised down to the tumor. In the dissection an abscess cavity, containing two ounces of creamy pus, was opened into. The mass, with adherent section of abdominal wall mentioned above, was isolated and found to be intimately connected with the transverse colon. The stomach was not involved. The gross diagnosis seemed to be that of a malignant tumor of the transverse colon. Resection of the transverse colon at this point including the tumor mass. The free ends of the transverse colon were then inverted with purse-string suture of Pagenstecher. Reinforcing by second suture. Lateral anastomosis then performed, using three layers behind and two in front, outer material being Pagenstecher. Opening in mesocolon sutured with

tion. At the operation the arches of the seventh cervical and upper three dorsal vertebræ were removed. There were numerous adhesions in the arachnoid binding that membrane to the cord and to the inner surface of the dura, and forming numerous sacs filled with fluid. The adhesions were divided and the fluid liberated. The patient improved very much after the operation, the spastic paraplegia had almost entirely disappeared. Complete control of the bladder had returned and the patient was able to walk around like a normal individual.

#### LAMINECTOMY FOR VARICOSE VEINS OF THE CAUDA EQUINA

DR. ELSBERG presented a young woman, twenty-seven years of age, from whom a large varicose vein had been removed from between the roots of the cauda equina with almost complete relief of all the symptoms. The patient's history dated back a year and a half. She had been bedridden for a year, and had an almost complete flaccid paralysis of the lower limbs with considerable loss of control of the bladder and rectum. There was loss of all sensation over the lower three sacral areas on both sides. At the operation the arches of the 12th dorsal and upper three lumbar vertebræ were removed. Between the roots of the cauda equina there was seen an enormous varicose vein, 5 centimetres in length and at least  $\frac{1}{2}$  centimetre in diameter. The walls of the vein were markedly thickened. The enlarged vein could be excised in one piece. The patient was presented six months after the operation practically well. She was able to walk around like a normal individual. The knee jerks and ankle jerks which had been absent before the operation had returned. She had regained almost complete control of the bladder and rectum.

Dr. Elsberg remarked that he had now seen a considerable number of patients with these abnormal enlarged veins within the spinal canal, and that in a number of patients the improvement after excision of the vessel had been as great as in the patient presented.

#### LAMINECTOMY FOR MULTIPLE EXTRAMEDULLARY SPINAL TUMORS

DR. ELSBERG presented a woman thirty-five years of age with the following interesting history: About two years before patient had begun to complain of attacks of pain in the right hypochondrium. She was suspected of having cholelithiasis and at one hospital a cholecystectomy was done. As the pain persisted, the appendix was removed by another surgeon, but without relief. For a number of months the patient had complained of peculiar sensations in the lower limbs, but little attention was paid to this. Finally she came into the hands of Dr. Abrahamson, who recognized that she had symptoms of spinal cord compression with root pains extending over the right side of the

to feel a weakness in his legs, especially that of the left side. The legs felt stiff and would jerk in bed. The right leg became affected about one month after the left and he soon noticed that the legs were becoming numb. The patient was almost entirely bedridden for three months. When he was admitted to the Neurological Institute on the service of Dr. Peterson, he was hardly able to drag himself around with the help of two canes. There was a marked spastic paraplegia of the lower extremities with slight sensory disturbance up to the sixth dorsal level affecting entirely pain and temperature sensation. Power in the lower limbs very poor. Knee jerks markedly exaggerated. Double inexhaustible ankle clonus. Double Babinski and double Mendel. Diagnosis: Multiple sclerosis. Decompressive laminectomy was done, the arches of the 5th-8th dorsal vertebræ being removed. The cord had the typical appearance of sclerosis. The patient had been presented two months after the operation. He had improved very markedly, all evidences of spasticity had disappeared; sensation was normal all over the body; control of the bladder was much improved, the patient having only occasional incontinence at night. When presented a year and a half after the operation, he was practically well, all evidences of spasticity having disappeared, and his bladder control now being normal.

Dr. Elsberg said further that at the Neurological Institute, Dr. Pierce Bailey and he—in the course of several years—have seen a number of cases in which, to their surprise, a most remarkable improvement had followed from the operation which they called decompressive laminectomy. As there was no increase of pressure, the name "decompression" is wrong; it is simply laminectomy with exposure of the cord. They thought that the entrance of air may change pressure conditions, may have an influence upon the spinal circulation, and may have something to do with the changes that occur. In a publication some months ago, a paper presented at the American Neurological Association, they tried to give an explanation for the remarkable changes that occurred, remarkable changes in the reflexes and improvements in the patients that they had seen in a large number of cases of spinal cord disease. A real explanation they could not give, but can only state that there are a certain number of cases which are astoundingly improved by a wide laminectomy.

#### LAMINECTOMY FOR ADHESIVE ARACHNITIS

DR. ELSBERG presented a patient who had been operated upon two months before on account of spastic paraplegia with sensory signs up to the second dorsal level, with weakness of the bladder and constipa-

## NEW YORK SURGICAL SOCIETY

### LAMINECTOMY FOR PACHYMEINGITIS

DR. ELSBERG presented a young man who had gone through a severe sepsis with multiple foci of bone suppuration. Amputation of the thigh on the left side had been performed by Dr. Beer. About two years before he began to suffer from increasing numbness and stiffness and loss of power in the right lower limb and with stiffness of the stump of the left thigh. This gradually increased until there was complete loss of power in the remaining limb with sensory disturbances and severe pain over the mid-dorsal region. Laminectomy was performed on account of suspicion of pachymeningitis, and at the operation a large amount of granulation tissue underneath the arches of the eighth and ninth dorsal vertebræ was found with marked thickening of the dura. The granulation tissue was removed with the curette, a large amount of inflammatory tissue excised from the outer surface of the dura, and the wound drained. This resulted in a rapid disappearance of all the spastic symptoms and sensory disturbances and recovery of complete power in the remaining limb. The patient was presented free from all symptoms and able to walk like a normal individual with the aid of an artificial limb on the left side.

### SUBCORTICAL SARCOMA REMOVED FROM THE PARIETAL REGION

DR. ELSBERG presented a patient of Dr. J. R. Hunt, who had been operated upon when he was in stupor. The patient had right-sided pyramidal tract symptoms, was aphasic, and had marked choking of the discs. A large osteoplastic flap was turned down over the left parietal region and the dura incised; the cortex appeared normal. When the brain was aspirated over the mid-parietal region a resistance was felt about 4 centimetres below the cortex; a small incision was made in the cortex just behind the posterior central convolution and a large encapsulated tumor, about the size of a pigeon's egg, was removed. Convalescence from the operation was uncomplicated; the eyes rapidly returned to normal; the right-sided pyramidal tract symptoms disappeared. The aphasia has been steadily improving, and now, three months after the operation, the patient is able to speak fairly distinctly, although his vocabulary is still limited. In connection with this case, the speaker made some remarks upon the diagnostic significance of passing a needle into the brain substance. The speaker has used a slightly roughened needle by means of which it is frequently possible to recognize slight differences of resistance in the brain. By this means, tumors have been discovered which would otherwise have been missed.

## REMOVAL OF CONGLOMERATE TUBERCLE FROM SPINAL CORD

abdomen from the sixth to ninth dorsal roots. The speaker performed a laminectomy and removed three spinal cord tumors lying under the seventh, eighth and ninth dorsal roots on the right side. The patient was at once free from her pain, but marked spasticity of the limbs required a root section, after which the patient was again able to walk around. In connection with this case, the speaker laid stress upon the importance of neurological examination in cases of patients complaining of indefinite abdominal disturbances. In not a few of these cases the abdominal symptoms have a spinal root origin. He had operated upon nine patients for spinal cord tumors or other spinal disease, upon whom previous laparotomies had been performed for supposed intra-abdominal disease. He also stated that the best results that could be obtained from posterior root section were obtained in spastic paraplegias due to old lesions of the cord either from long standing tumor or from trauma.

## EXTRAMEDULLARY SPINAL CORD TUMOR IN THE UPPER CERVICAL REGION, PROJECTING INTO THE FORAMEN MAGNUM

DR. ELSBERG presented a patient who had been quadriplegic with symptoms referable to the upper cervical region. On account of an X-ray diagnosis of spondylitis operative interference had been delayed for a number of months. At the operation the laminae of the first, second and third cervical vertebrae were removed and a large extramedullary spinal tumor projecting upwards into the foramen magnum was easily removed. The patient regained considerable power in all four extremities, and was able to walk around with the help of a cane, when presented. The speaker stated that the case was unique; in the surgical literature he failed to discover the report of a tumor in this location.

## LAMINECTOMY AND REMOVAL OF CONGLOMERATE TUBERCLE FROM THE SUBSTANCE OF THE SPINAL CORD

DR. ELSBERG presented a patient who had been operated upon two years before on account of loss of power in the lower extremities, bladder and rectal disturbances and severe pain in the lower abdomen. At the operation the arches of the ninth, tenth and eleventh dorsal vertebrae were removed. A small tumor measuring  $1\frac{1}{2}$  by 1 centimetre was easily removed from the substance of the cord after incision. The pathological report was tuberculoma. On account of the spastic paraplegia, posterior root section was done three months later. The patient had improved markedly, had regained control of his bladder and was able to walk around without any support. There has only been one similar case reported in the literature, the case of Veraguth and Brun in which a conglomerate tubercle was removed from the substance of the cord.



As applied to Volkmann's contracture this continuous stretching sounds a new note in the treatment of ischæmic contracture, enabling one eternally to pull on that scarred muscle, to stretch and absorb the scar, and elongate the muscle and to continuously take up all slack as it is created. The results presented by Dr. Taylor and the promise held forth by this method I have seen accomplished in no other way, most certainly not by operative procedures.

DR. ROYAL WHITMAN agreed with Dr. Taylor as to the principles of the treatment; that it was essentially mechanical and reconstructive, although he differed with him somewhat as to the practical details of its application. He judged from Dr. Taylor's remarks that he was not familiar with the practical application of the Jones treatment. Its purpose was to concentrate the corrective force at one point. In this deformity extension of the wrist caused flexion of the fingers and vice versa, and in several cases there was in addition contraction at the phalangeal joints. The fingers were first straightened by individual splints and fixed in the extended position. A metal splint was then adjusted to the flexed wrist and hand. This was straightened at intervals of several days until hyper-extension of the wrist was attained, usually in a comparatively short time.

It had certain mechanical advantages in severe cases over an apparatus designed to correct both contractions simultaneously. He thought Dr. Taylor rather too positive as to the limitations of treatment, since in his experience function might improve for years, indicating, apparently, regeneration of muscular tissue. He could not agree with Dr. Lilienthal as to the advantage of operative ankylosis at the wrist, because both the deformity and the contraction that induced it might be overcome by persistent treatment, while arthrodesis in childhood could not be depended on to prevent deformity.

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## VOLKMANN'S ISCHÆMIC PARALYSIS

### VOLKMANN'S ISCHÆMIC PARALYSIS

DR. ALFRED S. TAYLOR read a paper with the above title, for which see page 28 (January).

DR. HOWARD LILIENTHAL remarked that Dr. Taylor had presented his case in a most convincing manner. Probably many patients have been operated upon who might have recovered better by physiotherapy. He still believed, however, that there are some cases of Volkmann's ischæmic contracture which will not yield to anything short of the mechanical setting right of the limb. In future his plan would be to defer operation until it had been proven conclusively that in that case at least Dr. Taylor's method could not succeed. He believed that arthrodesis of the wrist with fixation in abduction and extension is more likely to be followed by permanent improvement than by any other operation of which he knew. With the wrist stiffened in the position he described the carpal movements are not missed as much as might be expected, provided the thumb and fingers functionate well.

DR. VIRGIL P. GIBNEY said that he had done many operations for the relief of the deformity which Dr. Taylor had so accurately described, but the mechanical treatment by the Jones method had yielded him the best results. He had not tried Doctor Taylor's elastic tension but he would certainly resort to it in the future management of these distressing cases.

DR. KARL KONNELL said that the principle of regaining function by stretching scar deformities through gentle constant pull over a long period of time is one that can be advantageously applied to scar tissue wherever it is met. Certainly the lesion described by Volkmann depends chiefly for its crippling deformity on the fibrous interstitial replacement of damaged muscle bundles by scar tissue and the cure would seem logically along the lines of the paper of the evening.

He was particularly impressed by what a tiny rubber band can accomplish in stretching scar tissue, as he saw this principle applied in the war surgery of the German clinics. It seems a far cry from shattered mandible to Volkmann's contracture, yet the scar tissue in these war wounds is certainly no less resistant than in Volkmann's contracture. In contractures following injury where the symphysis of the mandible was depressed almost against the hyoid bone, he saw it again pulled out practically to its normal position by two little rubber bands pulling from rigging cemented to the upper teeth and projecting in front of the face. Also deformities wherein bodies of mandibles laid together sidewise from loss of symphysis were corrected over a period of two or three months by a little elastic band each pulling laterally.

this can be ascertained by surface measurements and by palpation. The surface diameters should be given in inches or centimetres and the depth estimated by palpation or otherwise and expressed in the same scale. It is surprising how loth the medical profession is to give up the habit of describing tumors in terms of the vegetable kingdom. "As big as a hickory nut" or "the size of an orange," and similar expressions still find their way into descriptions where accuracy is of prime importance.

When I first began a review of the reports on radium published in the last two years, I thought it might be possible to summarize them so as to draw fairly definite conclusions. The indefiniteness of statement in these reports, and especially in the reports from individuals, makes any such summary impossible; but there is reason to hope that within a comparatively short time, some generalizations may be possible in connection with the reports from radium institutions. For example, the radium institute of London has published its reports for 1912, 1913, and 1914. This institution is said to deal only with inoperable cases. Omitting the patients who were seen but not treated, the totals for these three years were 539, 654, and 594, of which the cures and apparent cures numbered the first year about 15 per cent., the second and third years about 11 per cent. of the totals. Possibly the war may have had some effect on the number of persons applying for treatment in 1914. If not, and no other local cause existed to explain the very small increase in attendance, it seems a fair inference that the patients treated were not very favorably impressed with the results. A few more annual reports will bring this point out more clearly. It is absolutely certain that the future of any new method of treatment depends far more on what the patients think of it than it does on what the doctors think of it.

Will radium gain for itself a broad place in the field, such as that gained by plaster-of-Paris in the treatment of fractures? Or will its place be a limited one in the hands of only a few enthusiasts, such as that held by hydrotherapy? Or will it pass into practical disuse as blood-letting has done? Only the future can answer this definitely, but we can already see some of the conclusions upon which that future judgment will rest.

One of the generally accepted facts about radium is its ability to destroy tumor tissue. The way in which this is accomplished has given rise to much discussion, out of which has arisen the theory of the "selective action of radium." Some men have denied that it has a selective action upon the tumor cell; but most of those who have considered this question admit that it exists in some form. For practical

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## THE PLACE OF RADIUM IN SURGERY

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RADIUM's place in the treatment of tumors is still an uncertain one. Ten years' experience with it on the part of many experimenters, hundreds of articles in the medical press, even the monthly issue of several special journals, the publication of many books and endless discussions in medical society meetings have not resulted in fixing its value with any degree of definiteness.

At the present time there are some men who say that it has little or no value; while there are others who believe that it is destined to take the place of the knife in the treatment of tumors. Between these two extremes are scattered the opinions of the majority of surgeons, but these opinions have not yet grouped themselves around generally accepted truths. Herein lies the excuse for adding one more to the already formidable list of articles upon this subject. An extremist may continue to be an extremist in spite of the weight of evidence; for there are men so constituted that they always see what they are looking for. Men of slower decision must hunt through this overwhelming mass of testimony again and again, gradually building up a pile of definitely proved facts while spreading out for further inspection a great number of interesting possibilities.

In a review of this character it is unnecessary to refer to the technicalities of radium treatment; but one cannot too strongly urge upon all who write reports of cases, the great desirability of an exact description of patient and treatment. Wood states that there are only three factors of importance in the action of radium on tumor tissue: viz., time of exposure, dosage of radium and the distance between the radium and the tumor. In any report these data should invariably be given, as well as the nature of the tumor, its position and its bulk as nearly as

been disputed by others. These are tumors of the cervix and body of the uterus and tumors of the ovaries. The admitted facts in this connection are the production of amenorrhœa, the drying up of foul vaginal discharge and the cicatrization of ulcers. The skeptics claim that this is the sum total of the effect of radium in these cases. There is no doubt of the artificial sterility produced in these patients by the use of large doses of radium repeatedly applied for several hours at a time. It is also produced in the nurses who have to wait on the patients during the attacks of nausea caused by the radium treatment.

This amenorrhœa is sufficient to check the hemorrhage from uterine fibroids and probably sufficient to explain the partial shrinkage in the tumors which sometimes occurs. Similar changes sometimes take place at the normal menopause. But it seems a little far-fetched to explain the disappearance of cancer of the cervix, much less of the body of the uterus, as due to this artificial sterility, for no such phenomenon takes place at the normal menopause; yet there are not wanting men who claim to have effected repeatedly the cure of cancer which extended well into the pelvis. Perhaps the present attitude of conservative men who regard radium favorably is fairly stated by Ransohoff, who advises operation in operative uterine cases, but uses radium to stop the discharge and hemorrhage and destroy the cauliflower masses, when these symptoms develop in inoperable cases. The improvement of symptoms which results is in most cases only temporary.

Another important point in connection with radium treatment is how to decide when radium has effected a cure. In the scar tissue which takes the place of the apparently cured cancer, the microscope may reveal islands of cancer cells. Their vitality may be destroyed or they may be only dormant, depending upon the action of the radium. If such uncertainty exists in every apparently cured case, one will naturally hesitate to substitute radium for operation in operable cases, unless the tumor is so situated that it is worth taking some risk of recurrence to avoid the mutilation caused by operation. It may be that further experience will definitely determine to what depth tumor cells have been influenced beyond the possibility of re-growth; so that one may be as sure of their destruction for a given distance as if they were actually removed by operation.

The determination of the dosage of radium rests of necessity in the hands of those who use it; but anyone can enjoy the humor of the situation when the possessors of one hundred milligrammes or more of the precious element object to treatments being made by the men who have only ten or twenty milligrammes, on the ground that small quantities are

## THE PLACE OF RADIUM IN SURGERY

purposes it makes little difference whether the radium attacks the tumor cells simply because they are less resistant than the normal cells of the body; or whether there is some really "selective action" in the stricter sense of the word. One writer has even suggested that the influence of radium upon cancer cells produces antibodies which may be useful in causing the disappearance of metastatic nodules, but this is pure speculation.

If then radium has a destructive effect upon tumor tissue "selective" to the extent of sometimes causing its disappearance while injuring the normal tissue only temporarily, the next important question to be settled is this, "What kind of tumors are susceptible to its influence?" Nearly every writer gives a different answer to this question, but there are a few points of agreement nevertheless. It is generally admitted that radium causes the disappearance of keloids, which may be called tumors by courtesy, of lymphangiomata and of basal-celled epitheliomata in very early stages or if they are superficial. All of these growths, it may be noticed in passing, are either on the surface or so near to it that only a thin layer of skin intervenes between the radium and the normal cells. Beyond this general statement, there are instances reported by different writers of the disappearance after exposure to radium of almost every kind of tumor in almost every part of the body; but thus far no rule has been discovered by which the effect of radium in any particular case can be predicted with certainty.

There is, however, one group of tumors in which success has frequently been noticed, and another in which failure from treatment has been very generally admitted. In the first group should be placed the sarcomata and in the second group the prickle-celled epitheliomata. The rapidity with which one sarcoma will destroy the human body, while another is driven out by some apparently inadequate cause (for example Coley's fluid), forms a riddle which medical science has not yet solved. It is not to be wondered at that the behavior of these tumors to radium is therefore variable. Even a melanotic sarcoma of multiple form has been said to disappear after the use of radium as if by magic.

The resistance of prickle-celled epitheliomata may be due to their vitality or their tendency toward rapid growth away from the surface. The failure of radium to stop their growth has also been attributed to the situation of these tumors within the mouth or other cavities of the body where the prolonged use of radium produces an unbearable irritation.

In another group of tumors radium has frequently been employed, and as some have claimed, with great success; although these claims have

treated with radium. In the case of large rapidly growing tumors, sarcomatous or otherwise, so situated that operation is likely to prove unsuccessful or to have a high mortality, radium may be tried; but the proper place to test it is still in the recurrences. Many of them are situated near the surface, so that radium has the best opportunity for its action, and the investigator can determine the effect of treatment by inspection, palpation and measurement, and can remove tissue for microscopic examination from time to time. This is the proper field for research and it can be carried out without taking away some patient's best chance of a cure by surgical removal of his tumor.

When the investigator in radium becomes so expert that he can say with definiteness, "Here is such and such a type of tumor and its bulk is approximately so and so. I know from experience that I can cause its entire disappearance with so much radium applied for so many hours," it will be time enough to advise radium in primary operable cases.

liable to stimulate tumor growth and so do more harm than good. Meanwhile the owners of small amounts are publishing their striking successes with no less fervor than their wealthier brothers. If it is a question of veracity who shall decide between them? It is a good suggestion, and one well worthy of endorsement, that the owners of radium should be officially registered, and the amount of their radium should be recorded.

It seems very unlikely that a patient having secondary cancerous nodules in lymph-glands or elsewhere can be cured by radium. We have been repeatedly told that its influence after penetrating an inch of tissue is practically *nil*. A palpable metastatic nodule will often be near the surface, but by the time it is recognizable for radium treatment there are almost sure to be other metastatic nodules in other places, some of them quite inaccessible for recognition or treatment.

How explain then the reported instances of disappearance of cancer when lymphatic glands were involved?

There are three possible explanations: First, lymph-glands are often enlarged from other causes. Almost everybody has palpable lymph-glands in some situation. Second, ulcerative cancers often produce enlargement of the regional glands, when if these glands are examined microscopically it will sometimes be found that they are enlarged as a result of inflammation and are not cancerous at all. Third, in some cases even non-ulcerating cancers may be sufficiently irritating to produce glandular enlargement. If, therefore, a patient with a cancer and enlarged regional glands has been treated with radium with disappearance of cancer and glands it is not safe to assume that radium has cured metastases, unless at least one gland was previously removed and found to be cancerous, as might be the case if the patient were treated for postoperative recurrence.

This brings us to the last question and perhaps the most important of all. Shall a patient having cancer in operable condition be advised to have an operation or treatment by radium?

A fair answer to this question based on the published articles seems to be that operation should have the preference in cancer so situated that operation gives a fair chance of cure. In the present state of our knowledge, I think a man does his patient a grave injustice if he advises radium for a primary prickle-celled epithelioma, or for any primary cancer of considerable bulk, if the conditions are favorable for its removal.

Primary basal-celled epitheliomata of the face, lymphangiomata, and fibroids of the uterus, angiomas and keloids may all be safely



indebted to Dr. Robert T. Morris, of New York, Dr. Wayne Babcock, of Philadelphia, and Dr. J. C. O'Day, of Portland, Oregon, for their kindness in reporting to me the results of their work. There have been no deaths or serious results reported from the treatment. Dr. Babcock reports (personal letter) a fatality following the injection of hot water as follows:

"A patient who seemed in fair condition was brought to the operating room for ligation or lobectomy, when she became intensely excited and the pulse rate increased from about 130 to 170. The patient was nearly maniacal from the excitement. The operation therefore was not attempted and one lobe was injected with boiling water and the patient returned to bed. Tachycardia and excitement continued and three or four days later the patient died."

In so far as I have been able to learn, this represents the only undesirable experience occurring in relation with this very valuable treatment of thyroid intoxication, yet, to those who have had much to do with the treatment of this disease, it must be apparent that similar fatalities have occurred, and in precisely the same manner, long before Porter had given us his method of boiling water injections.

In our cases so treated, numbering seventeen in all, nothing but good has resulted, even those first treated, when lack of experience was accompanied by its corresponding undeveloped technic.

While the particular experience of Dr. Babcock's was a sorry one, it will serve admirably to force home one of the greatest uncertainties with which we have to deal in the treatment of hyperthyroid goitre. Let me assume in this way—our seventeen cases yielded because the thyroid intoxication had not progressed to the degree of producing pathological changes in any of the vital tissues. With Dr. Babcock's case, we may justly assume, this change had occurred. But how are we to differentiate the two? There are a number of such unfortunate cases that come to the thyroid surgeon where, to quote the distinguished Chas. H. Mayo, "The best one can do is to wish them (the goitres) out." We have merely to remind ourselves of the difficulties besetting every diagnostic means, when we try to deduce facts from an individual whose body is already overburdened in beating back the fury of a thyroid storm.

With every guide swept away, chaos where there should be order, catching the last faint call for help, in the dark, we throw a life line, but too late, they go down. A buoy and not a life line was needed.

## INTRATHYROID INJECTIONS OF BOILING WATER IN HYPERTHYROIDISM

BY J. CHRIS O'DAY, M.D.

OF PORTLAND, OREGON

WHEN Professor Miles F. Porter hit upon the idea of injecting boiling water into the thyroid gland for the relief of the distressing symptoms of hyperthyroidism, he could have had but one thing in mind for the injection to accomplish—namely, the destruction of the secreting epithelium of the acini.

Before venturing an experimental try out of his very unique idea upon the human subject, also that a reliable estimate of its effectiveness be known, the thyroids of a number of dogs were injected, subsequently extirpated and sectioned. Some of the experiments were carried on by Dr. W. D. Gatch of the Indiana University School of Medicine.

From the experiments on animals it was demonstrated that (1) the procedure is a safe one, (2) the immediate effect of the injection of boiling water was destruction of the gland-cells and colloid which is later replaced by connective tissue, and (3) a goitre in the dog can, by this means, be cured permanently.

Adhering to the technic evolved during the animal experiments, he injected hyperthyroid goitres at his clinic, where attaining similar results the method was recognized as a worthy and very effective surgical procedure.

Before publishing his first paper on the subject, in a personal letter, he very kindly called my attention to the matter, and after a detailed description of the technic, suggested my giving it a trial should opportunity for such treatment present itself. During the year which followed I was able to add four cured cases to the credit of this means of treatment. These four cases were treated during the year 1913, and while they represented my first experience with Porter's method, three have remained free from recurrence of the symptoms, while the other one, whose goitre was small, submitted to a partial thyroidectomy which resulted in a complete and so far permanent cure. In his paper on the subject (*Surgery, Gynaecology and Obstetrics*, January, 1915) in a summary of the clinical experience, Porter says, "This covers over one hundred cases, some of which were in my own practice, but the majority in the practice of other surgeons. I am especially

To tell any individual you are about to inject boiling water into his neck is no welcome piece of news. The mere suggestion of it cannot fail in making a rather unpleasant impression. What then should be expected from an individual whose whole nervous system has been thrown into the attitude of extreme fright from a toxic goitre? By exercising a little tact, saying nothing about the boiling water injections, beginning with a small needle, using morphine merely hypodermically at first, feeling one's way cautiously into the patient's confidence, will produce results not likely to be accomplished in any other way.

That no fumbling occurs while the hot water is being injected, three or four rings cut from large rubber tubing are slipped over the barrel of a 10 c.c. glass syringe; wearing two pairs of gloves, cotton inside of rubber, the operator is enabled to work without fear of burning his hands. From the time the syringe is lifted out of the sterilizer till the water has been injected, no time must be lost, for unless the water be hot enough to cook the tissue into which it is injected its purpose will be defeated.

Before the process of "cooking" has begun, the surgeon should have definite plans at hand for the attack. Remembering the good results obtainable by the Stamm-Jacobson operation of ligating the superior poles, we are now in the habit of beginning the cooking at the upper pole, each succeeding injection being carried downward, the needle point being so directed at each selected level that the destruction of the gland is wrought in strata. Unless some such order is maintained, one may be unconsciously reinjecting the same point, thereby hindering the systematic part by part destruction necessary in securing satisfactory results. When the gland is small, making the injections more or less uncertain, unless the condition of the patient be very severe, we have been able to obtain splendid results by exposing the thyroid and cooking it directly under the eye. This can be accomplished without elaborate preparation, under local anæsthesia. With the gland exposed in this way the effectiveness of the process can be fully appreciated. As the boiling water is being injected, the corresponding portion of the gland is seen to whiten into a bloodless, pulp-like mass.

## INTRATHYROID INJECTIONS OF BOILING WATER

There is such a variance of opinion throughout the medical world concerning the treatment of hyperthyroid goitre that prevailing conditions are not to be wondered at. If, however, one will go carefully into the records of such observers as Crile, Murphy, Mayo, Porter, Halsted, etc., it would seem that our present vaudeville style of treatment would yield to one which has for its purpose the reducing of the gland's power of secretion. But until such a general dissemination of knowledge has been obtained, the thyroid surgeon must expect to encounter cases in every possible degree of severity.

We must be taught here, as in many other surgical diseases, the creed of early recognition, and once the lesson has been learned such experiences as that reported by Dr. Babcock will grow markedly less.

We have merely to remember that such measures as preliminary ligation (Kocher), nerve blocking (Crile), artificial œdema (O'Day), and injections of boiling water (Porter) were each begotten in the spirit of a conservatism born of just such fatalities as the one mentioned above. When the existing conditions are still within the possibilities of safe surgery, partial thyroidectomy is, without doubt, the procedure of choice. It gives the very best results. It is only after this period has passed that we are compelled to consider the application of one of those measures which has for its object the bringing of the sufferer back to where surgery can be safely applied. Here it is where the injections of boiling water will be of the greatest value. Indeed, some of the patients have been so relieved that operation was refused. Porter reports similar occurrences.

While the injections of boiling water meet every requirement of the principle involved—namely, the destruction of the gland's acini—we have been taught to recognize the value of Crile's ano-association when applied jointly, particularly is this true in extreme cases.

During the time the gland is being destroyed, piecemeal, by each succeeding injection of the hot water, one cannot afford to include neglect of other beneficial measures. Prominent among which rest and quiet are most effective. The environment of silence with which we unflinchingly surround our tetanus patients may, with equally as much logic, be given to those who are suffering the continuous drive of a toxic goitre. Taking this view of the facts involved we must immediately become impressed with the great truths set forth by Crile in his "Kinetic Drive and Ano-association." With all these factors in mind and properly applied, "wishing the goitre out" will, in many instances, become a realization.

in the osteogenetic, periosteal layer. A waiting policy should be adopted, allowing nature herself to make the separation of dead from living bone. The periosteum should not be traumatized by the curette and should always be preserved. Gentle curetting later of the bony sinuses to remove necrosed particles, avoiding the periosteum, is allowable. When large, free sequestra are evidenced by the probe, the sinuses should be enlarged sufficiently to permit of the extraction of the loose sequestrum. The curette has been responsible for much damage to otherwise healthy bone and in many patients has simply increased the necrosis.

The treatment of defects in the entire vertical diameter of the lower jaw involves much thought and care and patience both on the part of the surgeon and the patient. At the outset, the surgeon should come to a thorough understanding with the patient, explaining that much patience will be required, since it may be necessary to graft two or three times, in case infection sets in after the grafting, also that it will be necessary to have the jaw fixed either by wiring the upper and lower teeth together or else by some suitable apparatus. Only by absolute coöperation between the surgeon and the patient can a good result be obtained. In a patient with extensive necrosis, where the remaining bone is thin and weak, the patient should be warned not to chew upon hard objects in order to prevent a fracture taking place. If a fracture should occur in conjunction with necrosis, the upper and lower teeth should be held in their proper, original occlusion by wiring the upper to the lower teeth, or by the fitting of some suitable apparatus which will be described later. If there result a space between the fragments when the teeth are held in their proper relations, then one may expect a filling in of a not too large defect by new bone, provided that the periosteum has not been destroyed by the infection or been injured or removed by too vigorous curetting by the general surgeon. In rare instances, the vertical defect may be large, resulting in one of two things: first, if the fragments have not been properly held, they may fall together and unite in such a position that chewing is impossible, due to the posterior displacement of the shortened lower jaw. It will be necessary in such a case to sever the point of union, to separate the fragments, to hold them in their proper relations until the opening into the mouth cavity is closed off, and then, later, to graft a piece of bone, or cartilage, into the defect. Second, the defect with the teeth held in proper alignment may be too large to fill in of itself, resulting in non-union, to remedy which grafting will be necessary. Let us instance a typical case to illustrate the procedures. In most instances the patient will be seen with a sinus discharging under the lower jaw. The teeth have not been held in their proper positions

# THE TREATMENT OF BONY DEFECTS OF THE LOWER JAW\*

BY CLARENCE A. McWILLIAMS, M.D.

OF NEW YORK

THE author is convinced that no surgical lesion is generally so badly treated as infection and osteomyelitis of the inferior maxilla. This is due in the first place to timidity and ignorance on the part of the dentist who sees these patients in the beginning. His ill-advised attempts to save abscessed teeth lead to more or less widespread necrosis of the jaw. Secondly, the general surgeon frequently attacks the necrosed area with the curette and chisel with too great vigor, thus increasing the necrosis by trauma.

To particularize a little further, the dentist should not attempt to save badly broken-down teeth by putting on full-grown crowns embracing the entire root beneath the gums, as this is a potent cause of pyorrhœa. Such teeth should be extracted before abscesses develop. In case an abscess has occurred, no delay should be followed in removing the abscessed tooth. If the abscess is simply around the root of the tooth and has not invaded the gum, extraction may be all that is necessary. If the infection has had time to invade the bone, the abscess will not be aborted by simple extraction of the tooth. How often patients say "My dentist would not extract the tooth until the swelling went down!" With most dentists this seems to be an axiom. Every so-called "gum boil" should first have the tooth extracted, this to be immediately followed by a good, free incision along the alveolar process directly over apex of infected tooth, following infiltration of the gum with 2 per cent. novocaine solution. If free drainage is not obtained, an incision should be made under the inferior maxilla at point of fluctuation, parallel with inferior border of maxilla. By early extraction and free incision inside the mouth, the acute condition is usually controlled.

The treatment of chronic osteomyelitis of the lower jaw should consist chiefly in establishing and maintaining good drainage and in free, frequent irrigations through the sinuses, which should be frequently probed to ascertain whether or not free sequestra are present. The surgeon should resist the first impulse to vigorously curette these sinuses, as by this means it is very easy for him to increase the area of the necrosis by injuring the delicate new bone cells that are forming

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\* Read before the New York Surgical Society, January 24, 1917.

taken in making the graft, always using Lane's fracture technic. In the first place the old scar is cautiously opened from below, exposing the lower borders of the two fragments. Working from below upward, the vertical margins of the fragments are bluntly freed for a short distance, avoiding the tissues on the posterior or inner surfaces, and the edges of the bone are freshened with the rongeur. A portion of the outer surfaces of the fragments is laid bare with the periosteal elevator, care being taken not to open into the mouth. Should the mouth be opened into, no grafting should be done at this time, but the wound should first be allowed to solidly heal, when another grafting attempt may be made. Of help in preventing the opening into the mouth is to have an assistant keep a finger in the mouth in the defect to tell when a dangerous approach is being made toward the mouth. It cannot be too strongly emphasized that the smallest opening made into the mouth at the place of grafting is an absolute contra-indication to grafting, for immediate infection of the graft from the mouth produces, without exception, death of the entire graft with its subsequent extrusion. On the other hand, a sluggish infection, not arising from direct contact with the mouth, which develops in the wound some days after the grafting, may have no subsequent deleterious influence on the entire graft, only a part of the graft necrosing away, this having occurred in three of my cases with eventual good results. In one of my cases, a soldier in France, the mouth was opened at the time of grafting, though this was unknown to me at the time of grafting. There was a copious, foul-mouth infection evidenced on the second day by a profuse discharge, which ultimately resulted in the death of the whole graft. My departure from France took place before I could re-graft the defect the second time. During the entire grafting operation the most scrupulous Lane technic must be followed: that is, sterile towels should be clamped to the edges of the wound to exclude contact with the skin. Then no part of any instrument touching the tissues of the wound should come in contact with the operator's hands in any manner. All instruments when once used should be re-boiled before use again. All ligatures and sutures should be passed and tied with instruments without contact with the hands. Only by such means can the conscience of the surgeon be free in case infection subsequently occurs. Infection at best is difficult to avoid even with the most scrupulous technic just outlined, because the covering of the graft with soft parts, separating it from the mouth, is necessarily very thin and these tissues are largely cicatricial in which the blood supply is necessarily very poor and, in consequence, the resistance of the graft to infection is bad. I cannot

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and the ends of the fragments have fallen together, where they may or may not have united. There may be inability to chew solid food owing to the posterior displacement of the lower jaw. The first thing to be done is to enlarge the sinuses, then to remove any loose sequestra. If none are loose, a small curette may be introduced and the bone may be gently curetted, avoiding contact with the periosteum. Then the surgeon should patiently wait for the healing of all the sinuses and the expulsion of the sequestra, meantime having the patient frequently irrigate the sinuses. If the patient is seen before the fragments have fallen together, then the upper and lower teeth should be held in their proper positions by wiring them together, or by adjusting some suitable apparatus. In all this work it is most advisable for the general surgeon to associate with himself a dental surgeon who shall have charge of maintaining proper occlusion of the teeth. In my hands, wiring of the teeth has proved a better and easier method of maintaining them in proper position than apparatus. After the sinuses have entirely healed, then the surgeon should consider the best means of filling in the defect. The grafting of either a segment of bone or cartilage into the defect is certainly the only rational line of treatment. This must be carried out with minutest attention to details. The first operation is preceded a few days by the fitting to the upper and lower teeth of Angle's gold or German silver fracture bands with loops on the buccal surfaces. At the operation an incision is made along the lower outer border of the jaw, the point of non-union is exposed, cicatricial tissue is divided, opening into the mouth as little as possible, though this is almost unavoidable. The fragments are forcibly separated by some instrument which can be gradually opened, a most efficient apparatus in my hands being a mouth gag which is provided with two movable mouth jaws which are opened by a screw (pulmotor outfit). After the fragments are sufficiently separated, bronze wires are fastened between the upper and lower loops of the fracture bands, thus permanently maintaining the width of the defect. The mouth will most certainly have been opened in this procedure, rendering grafting at this time futile because of the resultant infection. The wound is sewn up without drainage and allowed to solidly heal for several weeks before attempting any grafting procedure, the defect between the fragments being carefully maintained during this time by rigid, frequent inspection of the wires, which are apt to become loose. At best infection is the "bête noire" of bone grafting operations into the lower jaw. The immediate proximity of the graft to the mouth renders the maintenance of sterility very difficult even with an intact covering of the graft, hence the most excessive precautions should be



cavities in the teeth, or liquid diet may be administered. Feeding has not furnished any difficulties in any of my cases and none of the patients have complained of this. For various types of splints to hold the jaws see Morestin<sup>1</sup> and Mitchell.<sup>2</sup>

A second method of grafting is to place the ends of the grafts in contact with the freshened ends of the fragments, with or without kangaroo tendon sutures being passed through holes drilled in the extremities. This method does not hold out so good a prospect for life of the graft owing to the contact of bone to bone being much less. In addition the danger of opening the mouth is greater, since a larger posterior surface of the fragments has to be freed and laid bare. Such grafts have, however, the advantage of wedging the fragments apart.

The main lessons to be learned from these patients are as follows:

1. Infection from the mouth at the time of making the grafts is absolutely fatal to the entire graft.

2. Infection appearing weeks after the grafting, not dependent on immediate connection with the mouth, is by no means fatal to the entire graft. A part only of the graft may necrose away.

3. No grafting should be made in the presence of a sinus or into a granulating cavity.

4. Grafting should be performed any number of times until a successful result is obtained.

5. In view of the great liability of bone grafts into the lower jaw to infection, the author is inclined in his next cases to use costal cartilage as grafting material, since this is more viable than bony grafts and is not so liable to become infected.

6. Absolute immobility of the lower jaw is a *sine qua non* to a successful result. Wiring the teeth has proved, in the author's experience, more successful than splints. It should be maintained for three or four months after the grafting.

7. The inlaying of the graft (always with its periosteum) into grooves cut in the sides of the fragments would seem to be a more scientific procedure than an end-to-end grafting.

8. Metal sutures had best not be used, owing to their liability to invite infection.

CASE I.—Previously reported.<sup>2</sup> Result fine. The patient died a year after the grafting of pneumonia. Dr. Downes saw the patient before her death and will testify to the good result.

CASE II.—The first grafting in this patient was reported<sup>2</sup> previously. The report of the second grafting has not been published and is as follows:

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agree with Albee that a bone graft is at all resistant to infection. It is badly vitalized tissue, poorly supplied with blood, and in my experience much more liable to infection than normal tissues. It would be very advantageous if we could graft into a jaw defect some tissue more resistant to infection than bone. With this in view the suggestion of Morestin<sup>1</sup> seems most valuable. He uses costal cartilage instead of bone in making grafts into the lower jaw, maintaining that the resistance of cartilage to infection far surpasses that of bone, that cartilage does not become absorbed and that it can be very easily cut with the knife to any desired shape. The seventh or eighth costal cartilage can very easily be removed entirely or a segment may be cut out of one of them. It is beautifully tolerated by the tissues. It may be inserted end-to-end and held there by sutures or be inlaid just like a bone graft. In my next lower jaw grafting I purpose using cartilage instead of bone for reasons already given. To return to the bone grafting interrupted above, the vertical edges of the fragments having been freshened and the outer surfaces laid bare, transverse grooves are cut in the outer surfaces of the two fragments for at least an inch long with either a chisel or the twin motor saws. Two holes on each fragment are drilled from the sides, running into the grooves. Kangaroo tendon sutures are then threaded through these holes. A corresponding sized graft with the covering periosteum, the latter taken larger than the bone transplant itself, is cut out of the tibia with the marrow also. No hand touches this graft at any time. The graft is placed in the grooves prepared in the lower jaw under the kangaroo sutures which are then tied with instruments over the transplant, securely holding the graft in place. I formerly used metal sutures but have now substituted for them kangaroo tendon or chromic gut, since these have less tendency to invite suppuration than non-absorbable sutures. The wound is then closed by suturing the deep tissues securely over the graft and in contact with it and over this the skin is sutured separately. Before the anæsthesia is completed, care should be taken to see that the wiring of the teeth is securely and accurately maintained. A dressing is applied to the wound and between the dressing and the mouth a sheet of rubber tissue is glued with ether to the skin to exclude the possibility of dribbling from the mouth reaching the wound. The after-treatment consists in careful, frequent watching of the wires between the teeth to see that they do not become loose or broken. There must be no mobility whatsoever between the fragments for three months, for movement is fatal to grafts. In my experience the wires will have to be readjusted, tightened or replaced on an average of every two weeks. The patient is fed soft diet through any existing

surrounding tissues. Whole graft buried by plain catgut suture, bringing tissues over in front of it. Interrupted silk sutures in skin.

Went home on June 4, where she broke her grafted leg by tripping. Treated at home by family doctor with splints for 40 days.

July 31 came to office. Jaw looks finely. Limps slightly. Jaw healed solidly. Wires between teeth all broken. Replaced.

September 30: All wires removed. Great difficulty in wearing them because she invariably broke them. Graft feels finely.

Fig. 2 shows the graft seventeen months after it was implanted. Chews well. Motions of jaw perfect. Graft intact and solidly united.

CASE III.—Previously reported.<sup>2</sup> This patient shows the value of periosteum on a graft. In 55 per cent. of my experiments on bone grafting if the transplant was without the periosteum the graft disappeared. In this case it was entirely gone in five months. In November, 1910, I removed half the lower jaw from a lad of 12 for a large giant-cell sarcoma. Fifteen months later I grafted into the defect in the lower jaw a piece of rib which was entirely stripped of its periosteum. One end of the rib was bevelled and this was sutured to the freshened edge of the remaining half of the jaw. The wound healed by primary union. Five months later a röntgenogram showed entire disappearance of grafted rib. There never was any discharge from scar.

CASE IV.—This patient<sup>3</sup> was a soldier in France suffering from a shell wound of cheek, upper lip and nose, and with the loss of an inch and a half of the entire vertical diameter of the lower jaw (Fig. 3). The left half of the lower jaw was maintained by wiring it in its proper relations to the upper teeth during the entire healing process. Several plastic operations were necessary upon the soft parts. The final result of these is shown in Fig. 4. I grafted a piece of bone from his tibia with periosteum, end to end, in the defect, suturing it with chromic gut. Unfortunately I did not appreciate at that time that I had minutely perforated the mucous membrane of the mouth. A foul discharge immediately set in, resulting in the death of the entire graft which had to be removed *in toto*. I left France before I could re-graft this patient. I learned that he was subsequently sent to the Hôtel Dieu to be under the care of Professor Morestin.

CASE V.—Unpublished. J. C., aged nineteen. Admitted May 9, 1916. History 31,463.

Five and one-half months ago shotgun, accidentally discharged, caused large laceration of left side of chin and compound fracture of mandible. Three and a half months later (early part of March), while a sinus discharging pus was present, a Lane plate was inserted in another hospital, between the fragments. This

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J. O., Italian woman, forty years of age. Prior to the first grafting, consolidation had taken place in such a bad position that chewing of solids was impossible. The site of consolidation was chiselled through, the fragments separated and later a bone graft was inserted which was held with metal sutures. There occurred infection of the graft which necessitated its entire removal. The wound had entirely healed, the teeth being held as well as possible with wires in their proper relations, thus maintaining the defect. This was difficult, as the patient lived in the country, could speak no English, and always returned with the wires loose or broken.

Second bone grafting operation, May 18, 1915 (Fig. 1). Intranasal ether anaesthesia. Incisions along old scar in lower cheek; curved incision with convexity inward along right tibia. Pathology: The defect was dissected out, measured 2 or  $2\frac{1}{2}$  inches long transversely. The posterior fragment ended in a thin plate of bone anteriorly. The total vertical diameter of the bone had necrosed away. The lower teeth which remain have been wired to upper, maintaining the defect. Procedure: Old scar circumscribed and skin surface of cicatrix removed. End of anterior fragment exposed and cleared of tissue. Edge freshened with chisel. Posterior fragment exposed deep in tissues under masseter muscle. Was a thin bony sheet. Tissue reflected from both its surfaces for an inch. Hole drilled  $\frac{1}{2}$  inch from its edge. Drill hole in anterior fragment. The tissues between the fragments were carefully separated, an assistant's finger being in the mouth to prevent entering into it. Lane's technic throughout. Right tibia exposed. Length of bone required measured off and the periosteum cut  $\frac{1}{2}$  inch longer all about and divided. Motor saw cut the graft exactly as laid out and went into medullary canal, erroneously including the crest. Width of graft about  $\frac{3}{4}$  inch, thickness about  $\frac{1}{4}$  inch, and length about 2 inches. Each fragment end drilled. Chromic gut used. Periosteal surface of graft was placed in the defect toward mucous membrane of mouth posteriorly, the posterior side of graft was placed on outer side of the posterior fragment and held there by chromic suture (Fig. 1). Anteriorly a step was made in side of anterior fragment and into this the blunt, anterior end of graft was fitted and held there by chromic suture through drill hole in anterior fragment and through drill hole cut in the anterior end of the graft. Graft fitted finally beautifully in place. A small piece of the graft which had been cut off, measuring about  $\frac{1}{2}$  inch square with periosteum on it, was placed next to graft posteriorly as an additional osteogenetic stimulus and was covered over by the



FIG. 3.—Case IV. Shell wound of face of French soldier, involving lower cheek, lower jaw upper lip and nose. The loss of bone in lower jaw was one and a half inches longitudinally and involved the entire vertical diameter.



FIG. 4.—Case IV. Final result of plastic operations on face.



FIG. 1.—Case II. Shows end-to-end graft from tibia with periosteum held by kangaroo tendon sutures through drill holes.



FIG. 2.—Case II. Shows graft seventeen months after it was implanted. It was firmly consolidated with the ends of each fragment.



FIG. 7.—Case V. Shows the graft from the tibia inserted into grooves cut in the outer surfaces of the fragments.

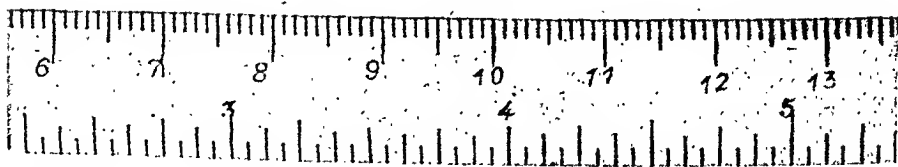


FIG. 8.—Case V. Sequestrum of graft which was removed three months after operation.



FIG. 5.—Case V. Shows improper closure of defect by a Lane plate, as this caused malocclusion of the teeth. Also shows buckshot peppering the tissues. These were not removed.

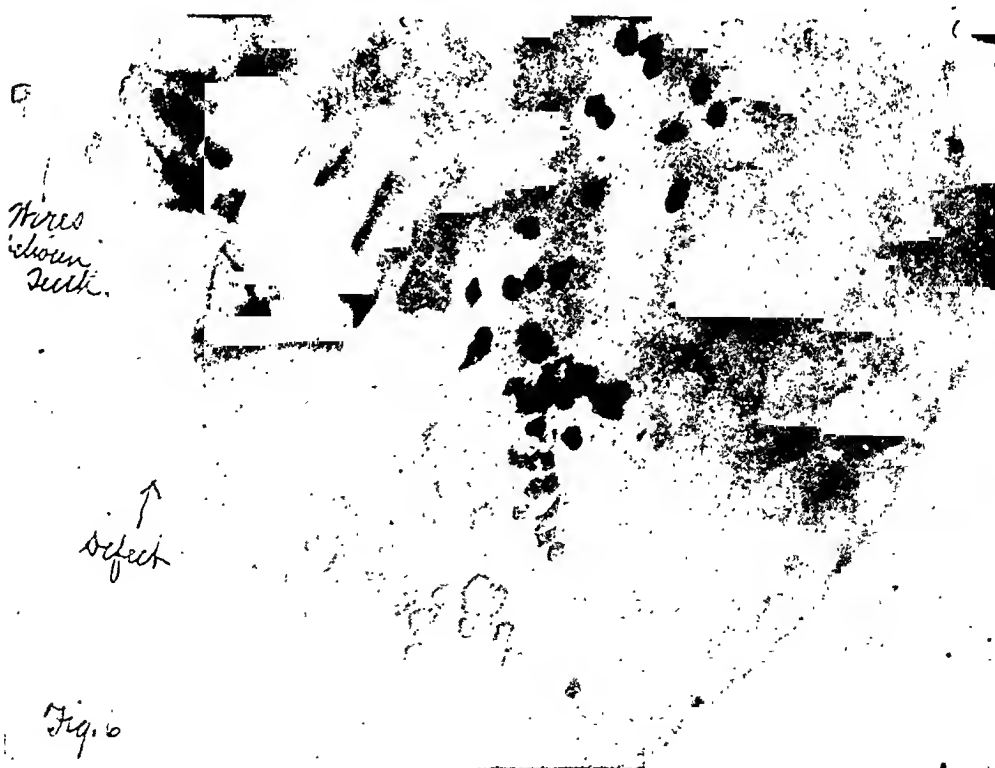


FIG. 6.—Case V. Result after removing the Lane plate, separating the fragments sufficiently to make proper occlusion between the teeth and wiring the upper and lower teeth in their proper positions. This brought out the defect.



2389

original  
defect  
filled by  
graft

L

Fig. 11.

FIG. 11.—Case V. Röntgenogram of defect in lower jaw. It has solidly filled in with bone from the graft despite the sequestration of part of it. Taken three months after the grafting.



defect  
A

FIG. 12.—Case VI. Shows defect made by bringing lower teeth in proper alignment with upper, where they were wired.



FIG. 9 —Case V. Shows plaster helmet and chest extension made to hold hand against cheek while pedicled flap from forearm was healing into cheek.



FIG. 10.—Case V. Shows result of grafting skin and fat, pedicled to the forearm, into the depression of the cheek.



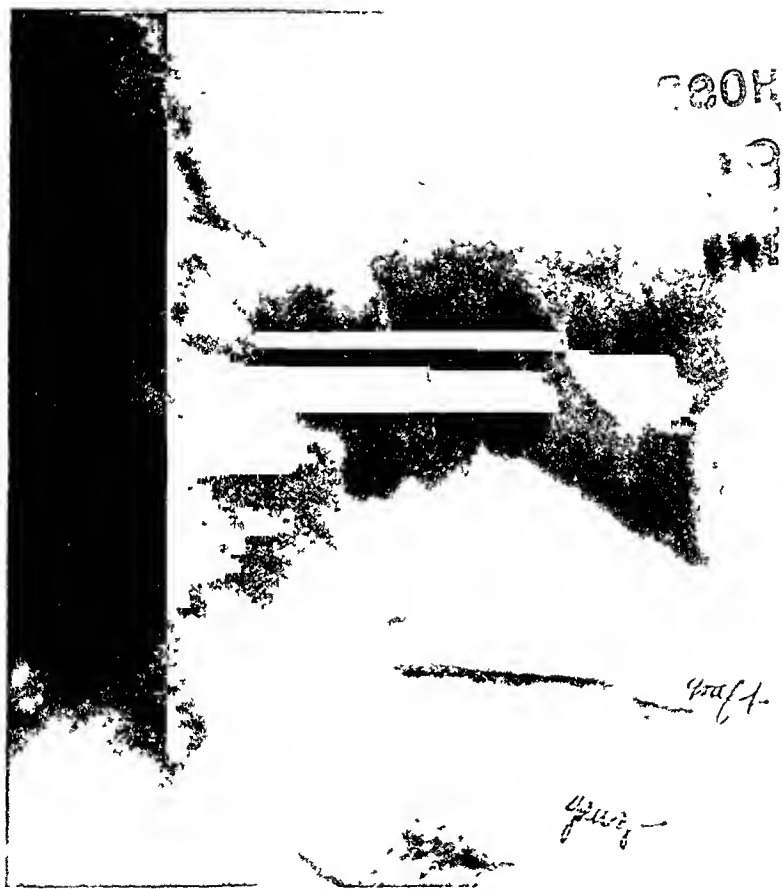


FIG. 13.—Case VI. Shows end-to-end graft from clavicle in position, pedicled by soft parts, held by kangaroo sutures.

posterior to middle line. Filled up with scar tissue. Defect had been fully maintained by wiring the separated fragments in their proper relations to upper jaw. Since first operation, clean wound.

*Procedure.*—Lower borders of the defect developed by separating the soft parts from them and this continued along the outer surfaces for an inch away from their free borders. In making a furrow across the defect carefully through the scar tissue a suspicious bubble occurred once as though the mouth was opened into by a minute perforation but there was no certainty. Along the outer surface of the posterior fragment a furrow was cut with the chisel and its edges were drilled in two places running into the furrow. Kangaroo tendons were threaded through the holes. In the anterior fragment a furrow was cut with the twin motor saws and holes were drilled in its lower border and kangaroo tendons threaded through them. From the right tibia was cut a segment with its periosteum intact, about three inches long, with the twin saws. The crest was not included in the section. There was marrow on the fragment. The graft was inserted in the furrows in front and behind and the kangaroo sutures were tied. There were two sutures on the anterior fragment and one on the posterior. The fit was very good. The skin edges were loosened up. Deep plain catgut sutures partially brought the deep tissues over the graft and the skin was sutured together with plain silk interrupted sutures. A starch bandage was placed under and around the chin and over the head. Rigid Lane technic was maintained throughout. The graft was not touched by the fingers at any time. No drainage.

*After-result.*—The skin over the graft was evidently too thin and cicatricial to remain viable with the amount of tension present. Two weeks after the operation there was some necrosis of its skin edges, exposing the graft beneath. This never closed. For three months the teeth were maintained immovable by wires. By this time a sequestrum (Fig. 8) had separated from the graft, and on September 12, 1916, it was lifted out by enlarging the sinus in each direction under novocaine anæsthesia. The wound healed solidly immediately thereafter. There was solid union between the fragments and all the wires were removed three and a half months after the grafting. There was considerable stiffness of motion in the lower jaw at first, but by the patient forcing the lower jaw down with his fingers continually a very good opening of the jaw was obtained. Chewing has been perfect since that date. A plate provided with four false teeth was made to fill the defect inside the mouth. The result has been perfect.

The patient was not satisfied with the depressed scar on his face so I agreed to try to remedy this. I have never had success

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loosened in two and a half weeks. A sinus persisted till two weeks ago, when it closed (Fig. 5).

*Examination.*—On the left side of the lower jaw is a large, stellate scar with a depressed centre attached to the bone beneath. The mouth can be opened only one-third its normal extent. On closing the teeth the lower incisors are posteriorly placed one inch behind the upper, rendering effective chewing impossible. There is evidently a loss of substance of about an inch in the vertical diameter of the left side of the lower jaw with considerable mobility of the fragments. There is no sinus. Röntgenogram showed the neck studded with buckshot and there was a loose Lane plate between the ends of the fragments (Fig. 5).

*First Operation* (May 11, 1916).—Intranasal ether anæsthesia, through tubes in the nose. Incision: Transverse along left lower jaw beneath the defect.

*Pathology.*—Non-union of the fragments which had approximated each other on the left side. The defect, when the fragments were separated into their proper positions, measured about one inch transversely. With the fragments unreduced there was no approximation of the lower teeth to the upper, the right larger fragment being drawn over to the left so that the lower teeth were one inch posterior to the line of the upper teeth. There was no dead bone evident anywhere.

*Procedure.*—Fragments exposed and search made for the Lane plate with two screws as seen in the X-ray plate. This withdrawn after exposing it. Fragments were separated to their proper relations and were wired in these positions to the upper teeth by Dr. V. E. Mitchell (Fig. 6). In making the separation the mouth was opened. Rubber tissue drain externally in middle of wound. Continuous silk skin suture. No attempt was made to extract the numerous buckshot. None were seen in the wound during the operation. A future lead-poisoning from these retained lead bullets is a possibility but scarcely a probability. Very few cases of such subsequently occurring are on record.

*Comment.*—The previous application of a Lane plate in this way was a wrong procedure, for, by bringing the ends of the fragments together, malocclusion would have resulted had they healed in this shortened position. Instead the teeth should have been wired together in their proper relations.

*After-result.*—The wound healed almost by primary union.

*Second Operation* (June 7, 1916).—Bone graft from tibia into defect in lower jaw (Fig. 7). Intranasal ether. Incision along under side and parallel to lower border left jaw. In right leg middle, curved incision with convexity anterior.

*Pathology.*—Defect in lower left jaw one inch in breadth just

defect has become filled in with new bone (Fig. 11) and the alignment between the upper and lower teeth as well as the movements of the jaw are sufficiently satisfactory to perform mastication perfectly. In addition the scar has been made much less disfiguring (Fig. 10). I should like to ask the members of the Society what success they have had with the Krause-Wolff free skin grafts and whether I would have been justified in making such a graft in this patient's face?

CASE VI.—H. C., colored, aged thirty-three, admitted August 26, 1915. Sent to me by Dr. H. S. Dunning from the Dental College. On March 16, 1914, patient was struck with a "black jack" which produced a compound fracture of the lower jaw. The fracture was a little to the right of the symphysis. Inflammation and swelling set in and he went to a hospital, where a piece of bone was taken from the jaw and four teeth were extracted. In six weeks the sinus had healed, but he could not chew his food. For ten months, at intervals of two weeks or more, there was much pain in the jaw, it was hot and tender, relief being felt when pus was discharged. At present the patient can open his mouth only half its normal extent and cannot chew. Examination shows an irregular scar with two sinuses, each exuding a drop of pus, in the middle of the right ramus of the mandible. Right ramus is angulated inward; left ramus has fallen in to fill up defect in bone, producing no occlusion whatsoever to teeth. There are motion and crepitus at the fracture spot.

*First Operation* (August 27, 1915).—Intranasal ether. Incision along right lower jaw.

*Pathology.*—The left half of the jaw had drawn over to the right to fill up the defect of an inch transversely, consisting of the entire vertical diameter. No attempt was to be made to graft bone from the tibia into the defect until all the sinuses should have closed. Infection came from the roots of two teeth which had to be extracted. These roots opened directly into the operative wound. No dead bone seen.

*Procedure.*—Incision carried down to the edges of the defect. A projecting lower, pointed end of a tooth was seen above. This tooth drawn and one anterior to it. This opened the mouth and later the mucous membrane had to be opened for at least an inch. The defect was then increased by drawing the left half of the jaw over until it came in its proper relation with the upper, where it was wired to the teeth. The defect between the bones was then at least an inch wide and one looked directly through the defect from the outside into the mouth. No dead bone visible anywhere. Mucous membrane sewn over the defect with catgut. Rubber tissue drain followed by continuous black silk suture in skin.

## THE TREATMENT OF BONY DEFECTS OF THE LOWER JAW

with the Krause or Wolff free grafts, consisting of the entire thickness of the skin, although Krause reports a number of such graftings into the face with success. Presumably the rich facial blood supply has had much to do with this. I determined to transfer a flap of the whole thickness of the skin with the fat pedicled to the forearm, into the freshened defect.

*Fourth Operation* (September 27, 1916).—Intranasal ether. Plaster helmet (Fig. 9) was made the day before operation, going around shoulders and with a prolongation to support right arm. Scar in cheek dissected all out and loosened up from the underlying tissues, resulting in a triangular raw area, whose base below was two inches, with apex above. Right forearm prepared and a flap three times as large as necessary to fill the defect dissected from middle of forearm with base towards wrist and about three inches long, the fat being included in the flap. This was turned so the raw surface came against the raw surface of the defect and its tip sutured with finest silkworm gut to the skin edge of the face posteriorly and also as far below as possible. Hand then bound to head helmet with plaster bandages and plaster also applied about chest and right arm.

*After-result.*—The patient suffered so much from the confined, high position of the forearm that on the ninth day after the formation of the flap, it was determined to sever the flap.

*Fifth Operation.*—After being made unconscious, flap was divided close to forearm. Plaster helmet was then divided and removed. The edges of the flap were trimmed and some of the under surface of the flap. The flap was adherent for one inch posteriorly to the skin of the face. Anteriorly, the depressed portion of the scar was excised and the edges lifted up. All about the defect the edges were freshened. The defect was triangular with base below of about two inches length. The flap was trimmed so that it filled the defect without tension. It was sutured to the face by finest silkworm gut sutures. Under its lower edge a slip of rubber tissue drain was placed. The result was good. Over the graft rubber mesh was placed and gauze wet in salt solution. The raw area in arm was covered in spots by the entire thickness of the remnants of the face flap, cut in small pieces, from which all the fat was removed, Wolff grafts. These were covered with rubber mesh.

*After-result.*—The graft into the face took almost by primary union, except at its most anterior edge, where there was a slight necrosis. Much to my surprise the Krause grafts into the forearm all took beautifully. It was later thought best to apply some "pinch" skin grafts to close the remainder of the forearm wound. The patient is to be congratulated on his patience in enduring all these procedures, but the good result has well repaid him. The



incision made half an inch wider on each side and carried down in a circle one inch below clavicle on chest. It was surprising how much the skin contracted when divided. Flap dissected half-way to lower jaw, going beneath deep fascia and platysma. Transverse division of periosteum on clavicle, the length of the graft being about one inch and a half. Longitudinal anterior division of clavicle for requisite length into medullary cavity and posterior transverse division by motor saw. This motor saw was supplemented by metacarpal saw. Small chisels then inserted broke off the graft from posterior part of clavicle with division of posterior periosteum somewhat larger than the bone graft. Incisions then made up vertically along the neck, carrying the original lateral incisions up, dividing the platysma and reflecting this up with the flap. It was necessary to make the flap up to the middle of the neck before it could be reflected into the defect, where it was twisted upon itself to bring the skin surface external. Drill holes made on each end of the graft. Kangaroo tendons threaded anteriorly and posteriorly and tied. Graft in good position between ends of bones (Fig. 13). Upper margin of skin edge sutured to upper edge of defect with interrupted black silk. Two plain catgut sutures between lower edge of defect and skin over graft. Remainder of wound closed with black silk. Considerable undermining had to be done before tissues came together over neck and shoulder. At first fascia brought over defect in clavicle by three catgut sutures, then side-to-side union of upper part of skin defect and the final closure was made by an inverted "T," the cross-bar being on the shoulder. Interrupted silkworm gut sutures used. Rigorous Lane technic throughout.

*After-result.*—At the end of a week there was gangrene of the pedicle which had to be cut away in consequence. For a time it looked as though the graft might live but this proved illusory. The infection was too much for the graft to retain its life. It finally entirely sloughed and had to be removed. During an absence in France, I lost track of this patient and now I cannot find him. I should try to persuade him to let me graft his jaw again could I see him. As a result of this procedure I doubt if I should again attempt to transplant a bone graft into a granulating cavity, although several such successful graftings have been reported.

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- <sup>2</sup> Dunning, McWilliams and Mitchell: Osteomyelitis of the Lower Jaw. Surg., Gynec. and Obstet., September, 1915, p. 306.
- <sup>3</sup> McWilliams: Jour. Amer. Med. Assoc., vol. lxvi, April 8, 1916, p. 1085.

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*After-result.*—For three weeks food and saliva came through the wound, then the wound healed solidly.

*Second Operation* (September 15, 1915).—Intranasal ether. Incision over left side of lower jaw through old scar.

*Pathology.*—Teeth had been wired in their proper relations and held so. The defect (Fig. 12) was about  $1\frac{1}{2}$  inches to be filled. This area was filled with scar tissue. After opening into the mouth by accident it was deemed inadvisable to graft because of infection. As it was impossible to open the scar again without opening the mouth if it were allowed to heal, the wound was packed.

*Procedure.*—Scar opened cautiously. Ends of fragments exposed and freed. The anterior fragment was rough, so it was smoothed off with the rongeur. The posterior fragment was a thin plate, necrosis had removed all the horizontal plate posteriorly. On attempting to make a furrow in the soft parts, the mouth was opened. The opening was about the size of a dime. This was sewn up with plain gut. It was thought best to try to let the cavity granulate and then to graft into this later. Wound strewn with aristol and packed. Starch bandage about the head.

*After-result.*—Very little discharge from the wound and practically no mouth discharge. October 5, 1915, granulating cavity was half closed in, and mouth was entirely shut off. Had been dressed with aristol. Wires had been removed, because they became loose very easily, and an interdental splint made by Dr. Mitchell was substituted, which was worn at time of operation.

*Third Operation* (October 5, 1915) (Fig. 13).—Intranasal ether. At each of the two preceding operations to make a furrow to lodge the graft, the mouth was opened. So at the end of the second operation I decided to close the mucous membrane of the mouth off with sutures and to let the remainder of the wound granulate and into this granulating cavity to insert later the graft. Since a pedicled graft is more liable to live in the presence of infection than a free graft, it was decided to pedicle with the overlying skin a graft from the clavicle into the defect. A free graft in the presence of infection *might* live, but it would be very uncertain, since infection was known to be present.

The original incision in the jaw was prolonged anteriorly over the ends of the bones. The whole incision was scraped out so as to remove the granulating tissue from the soft parts, and tincture of iodine was applied. The anterior end of the bone was laid bare and was very thick through. Rongeur freshened the edge. Hole bored through the end transversely. The posterior edge was freed and freshened with the rongeur and drilled through, its anterior surface being pried free of tissue. Exact length of defect measured with piece of rubber tissue. This laid on clavicle and marked out as being the length of bone desired. Skin

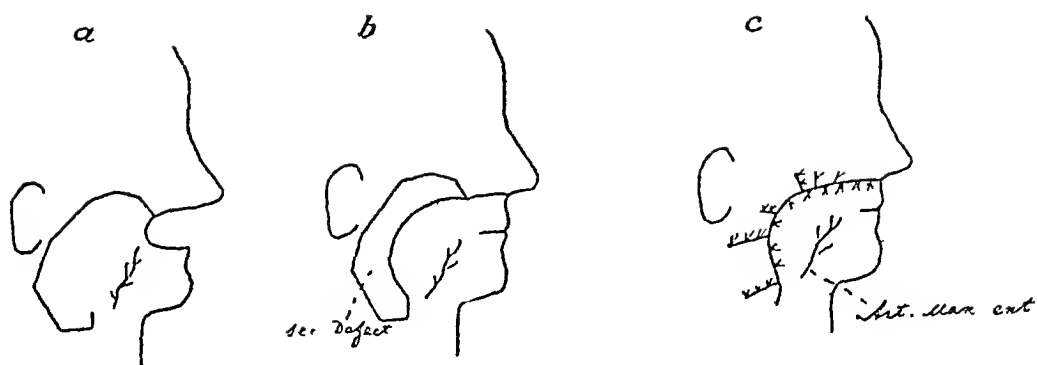


FIG. 1.—Upper lip defect.

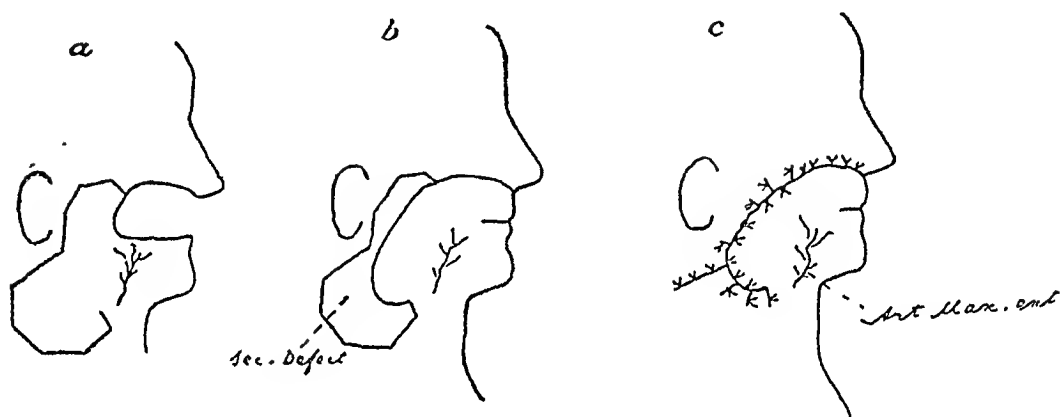


FIG. 2.—Lip-cheek defect.

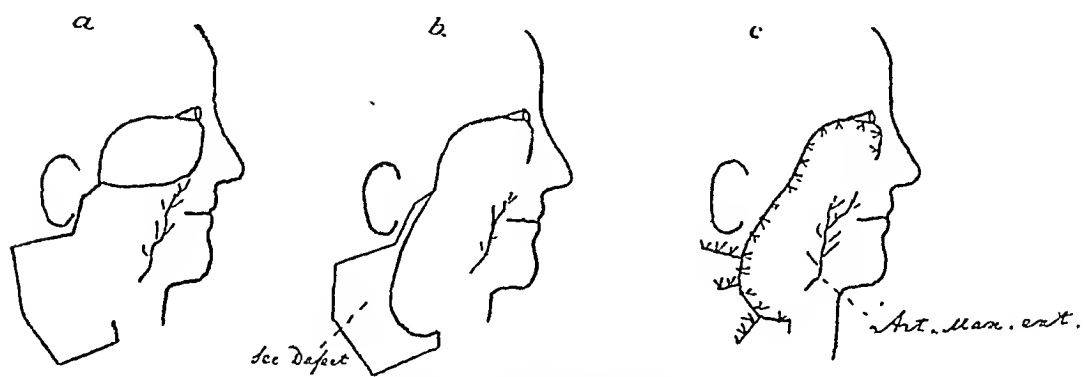


FIG. 3.—Eyelid-cheek defect.

# STUDIES IN PLASTIC SURGERY OF THE FACE

I. USE OF SKIN FROM THE NECK TO REPLACE FACE DEFECTS. II. PLASTIC OPERATIONS ABOUT THE MOUTH. III. THE EPIDERMIC INLAY

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OF HOLLAND

SPECIAL SURGEON FOR PLASTIC OPERATIONS AT THE K.U.K. RESERVEHOSPITAL NR. 8, VIENNA

## I. USE OF SKIN FROM THE NECK TO REPLACE FACE DEFECTS

IN this war I went to Austria to help to repair and undo a little part of the cruel mangling that millions of men have produced over all Europe. First, during eight months, I was chief surgeon of a very large barrack-hospital with 3600 beds, in Moravia, and afterwards I worked till now in my special branch of plastic work in different hospitals of Vienna and in the University surgical clinic of Hofrath Prof. von Hochenegg. As I made in Austria over 700 plastic operations on war-cripples I enlarged my practical experience, especially in repairing defects of the face in an important manner. In the present paper I desire to present a new operative system, which I introduced for repairing upper lips, cheeks, eyelids and noses.

The methods in general use did not satisfy me, as the results were not sufficient in an æsthetic and functional way. The use of the pedicle flap of skin from the arm or wandering flap from the breast is generally, besides its disagreeable technic for the patients, decidedly disfiguring. The color, paleness, hairlessness, flaccidness and other particulars or qualities differ so much from the skin of the face, especially in the neighborhood of the nose, that such a technical successful plastic only succeeds in closing the defect, but does not construct a proper lip.

Perhaps a temple pedicle flap is better, partly hairless for mucous membrane, partly with hair for the skin of the lip (Lexer). I saw a case in Prof. v. Hochenegg's clinic, where Dr. Demmer had used for replacing an under lip and mucous membrane a very large temple pedicle flap; partly with and partly without hair, with a pedicle scarcely finger broad; the temporal artery, with its branches, had been found and marked out with lapis before the operation. The result was very satisfactory. In general I do not like this method, as the temple defect is most difficult to heal æsthetically.

My cuts for upper-lip-cheek defects vary according to the size and place of the defect. They all have the same principle, that the arteria maxillaris externa lies in the centre and the cut first rises, then makes a broken curve, passing under the ear and taking more or less of the

collodion on the fistula and as soon as the liquid is nearly dry, I press a little cotton wool with the finger for some moments on the fistula. If pus has collected under the wool, the next day, I take off the collodion skin and wait till the wound has cleaned itself. This collodion treatment is repeated till healing ordinarily appears. I never saw a fistula remain which had to be operated, which can only be explained by the fact that I never cut through the ductus stenoianus, but only injure the gland tissue of the frontal terminals of the parotis or parotis accessorius.

I will give some specimen cases of my material in this method, showing how different kinds of defects may be treated.

CASE I.—Soldier S. (Figs. 4–7), K. u. K. Reservespital Nr. 8 at Vienna. The patient had lost an eye, the greater part of the cheek and of the under eyelid by granat-shot. He had been operated elsewhere, but the plastic had not succeeded. There was placed a pedicle flap partly hairless, partly without hair from the temple, and turned till the axis stood horizontally, and was then sewn into the eyelid-cheek defect. The flap had not sufficed as Fig. 4 shows and finally had shrunk through necrose, besides it had wrinkled and was very hairy. The temple (secondary defect) was very deformed as the substitute was quite hairless and consisted only of scar, wound and Thiersch islands. Therefore I tried to undo this work as far as possible. After cutting out the original temple wound, I unfolded the flap of the cheek, which was very difficult to do, as the folds were deeply seamed. Finally, the replacement of the flap succeeded very well, as shown in Figs. 5 and 6. After that the new cheek-eyelid defect was repaired with cheek-neck skin flap as described and shown in the diagrams. The healing retarded only in some stitches near the ear-lobe where a temporary paresis of the mouth facialis branches arose which soon disappeared. After this first operation skin material was present everywhere, as Fig. 5 shows. Afterward some corrections had to be made. Fig. 6 shows the result after the second one, which enlarged the length of the cheek at the cost of the width by taking a pedicle flap including the vertical scar of the nasolabial fold, turning it upward till it was horizontal, then placing it under the eyelid in horizontal incision so as to elevate the lid. Fig. 7 shows the situation after another correction of the eyelid and levelling the cheek.

CASE II.—Soldier B.T. (Figs. 8–11), K.u.K. Reservespital Nr. 17 at Vienna. Complete upper lip defect after a gunshot—broad, deep scar in the right cheek, besides defect of processus alveolaris on the right and in the middle. The mucous fornix was missing there. After the first operation in my method here given the

neck, according to size of defect (Figs. 1-3). The end of cut is always suddenly vertical, so as to make the whole movable. In some cases both cheeks are used, but mostly one side suffices, even for very large defects. After making the piece as movable as required, it is then turned and placed in the defect. The cut varies according to the presence or absence of hair, and if the defect also extends to the eyelid. Further, a somewhat similar cut is necessary in the mucous membrane of the mouth, again commencing at the same place and in the same direction, but turning before reaching the ductus stenoianus. At the end of this cut is also a sudden perpendicular incision to facilitate its removal. The mucous membrane cut is not only important for the removal of the whole part, but also because the sewing together of the mucous membrane wound after the removal supplies a surplus to be used for the inside of the new lip. The first part of the cut may split the entire cheek, but further on it must gradually be less deep for fear of injuring the facial nerve or the ductus stenoianus. That the nourishment of this turned cheek piece, one can scarcely call it a pedicle flap, is very good, is shown in the sketches attached and in the good results of the operations. The healing is without exception beautiful, as nowhere is any great difference in color or quality of the joined skin parts. The tension is, as far as the neck, quite regular. At the neck itself it is the greatest, so that we can say, practically, the defect is replaced by skin from the neck. The secondary defect, after the primary defect is closed, is mostly shown by a great gap in the neck. The wound edge at the back is then diminished by sewing the edge together at the cut intervals (*vide* diagrams). These stitches can bear very much tension. In this way the back edge approaches the front one, till they can be easily sewn together. I never leave any part unclosed. This I do in all my facial plastics. It is only possible because a beautiful plastic is always a mathematically correct and maximally economical one, and there remains no unused folded skin in the turned pedicle.

The apparent danger of injuring the ductus stenoianus and nervus facialis is, by careful technic, very small. Only once I met with a temporal facial paresis, which did not appear directly after the operation, nor the next day (as I never give dressing, I at once see any disturbance), but only some time later. It has arisen in consequence of the inflammation of a few stitches near the ear-lobe, where the healing did not immediately set in, but followed later on with good result.

Sometimes small salivary fistulas appear which heal in a few days without lapis treatment. I don't like the use of this, as it leaves scars. In such cases, after thoroughly cleaning with ether, I put two drops of



FIG. 13.



FIG. 14.



FIG. 15.



FIG. 16.



FIG. 17.



FIG. 18.



FIG. 19.



FIG. 20.



FIG. 21.



FIG. 4.



FIG. 5



FIG. 6.



FIG. 7.



FIG 8.



FIG. 9.



FIG. 10.

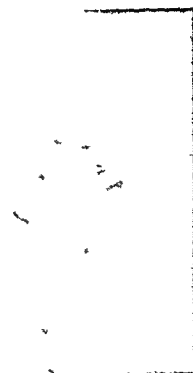


FIG. 11.



FIG. 12.



## II. PLASTIC OPERATIONS ABOUT THE MOUTH

In defects and deformations of the under lip many and various methods by plastic operation have been applied. Mouth operations have occupied surgeons since the ages of antiquity, and belong to the most difficult plastics that exist when a fine result is desired; however, they are very easy when patient and surgeon are soon satisfied. The elastic surroundings, with loose fixture on the bones at a distance and with excellent vascularization, make it possible to close the defects after various methods with good healing results. Later the continual work of the free and muscular surroundings helps to improve the results.

Nevertheless, after all, a mouth result almost always in respect to movement, shape or size, leaves much to be desired. The absence of bony fixture of the mouth tissue, however it may facilitate the joining of the defects, demands an independent regular construction of the new mouth, as one finds nowhere any firm support.

The great number of procedures which are all used satisfactorily, declare that every one affords good help but no one gives entire satisfaction. We find drawings and descriptions of these methods *in extenso* by Bockenheimer (Plastische Operationen), Lexer (Handbuch der chirurgischen Technik, edited by Bier, Braun and Kümmel, or in the Handbuch der Chirurgie, by von Bruns, Garré and Küttner) and F. Krause (Lehrbuch der chirurgischen Operationen) and in other surgical books.

Confining ourselves to the lower lip plastics, after mentioning the simple vertical sewing together of wedge-shaped defects, and a similar procedure on horizontal ones (Bockenheimer), the methods of Dieffenbach, Langenbeck, Jaesche, Trendelenburg, Sultan, Burow, Blasius, Lexer and Morgan, who all take their flaps from underneath the mouth line, are to be mentioned. Then follow those who take the substitute for the lower lip from above the mouth line (von Bruns (two kinds), Estländer). Israel with his neck flap forms a separate group, as does Lexer with his temporal flap.

Each of these methods has its certain advantages and disadvantages which I cannot detail here. I will only mention that till now not a single one has fully satisfied me—some for logical mathematical reasons, *e.g.*, the simple vertical and horizontal sewing; and the method of Burow for sacrificing too much tissue.

It should be the greatest exception to cut out pieces of sound skin and tissue to facilitate a plastic closure; all the proportions will unneces-

practical and æsthetical results were already good, though on the right cheek was a large scar. The jaw and the face muscles were all freely movable, only the mucous fornix was failing to receive the dental prosthesis. On the left side, where the same method had been used, the healing was beautiful. Some small corrections still have to follow. Figs. 10 and 11 show the patient after the first operation *before any correction*. As the correcting operations are not yet ready, I mention only the first result.

CASE III.—Soldier H. (Figs. 12–15), K.u.K. Reservespital Nr. 17 at Vienna. Shot injury of the right upper lip; nostril quite drawn aside, and mucous fornix defect. By cutting the cheek only to the neck, I could obtain a sufficient flap to cover the defect caused by the excision of the scars. The nostril was at the same time released and set right. Some small corrections were made afterward. The upper lip shows still a little œdema, which disappeared afterward by massage. Fig. 13 shows the result of the first operation, Fig. 14 after the correction of the cheek scars, Fig. 15 after lip correction.

CASE IV.—Soldier L. (Figs. 16–21), K. u. K. Reservespital Nr. 8 at Vienna. Total defect of the upper lip. Processus alveolaris nearly fully absent, perforation of the bony palate, cheek scarred, upper jaw grown together in a downward position after fracture. The right eye, quite blind, had slipped down, following its support. The nose was quite crooked and turned inward.

Here I came out with my method by making a large cut only on the right side, put besides, however, the skin part from between the two cheek scars as a pedicle flap (pedicle near the nose), first into the lip defect and joining the large patch to it, which also filled up the secondary defect made by the first flap. The new defect caused by the displacement of the large flap was closed in the ordinary way.

This particularly complicated proceeding made more after-corrections necessary, but was requisite on account of the situation of the two large, very deeply branched scars. Figs. 18 and 19 show the result after the first operation, Fig. 20 after a plastic of orbicularis oris muscle with mucous membrane (a pedicle flap from the under lip), Fig. 21 some weeks later on. There must still be made many small corrections before the case is finished; and because it is very important that between two corrections a very long time elapses till the vessel communications in the connecting lines are good, it will take several months before all is finished.

As this publication only intends to show the principles of my method of repairing facial defects from the neck, it was not necessary to wait till all the corrections of the cases were ready.

vessels and nerves; his other method with two square flaps, rising from the mouth corners, has great advantages, only the scars of the secondary defects, which go up and aslant from the corners of the mouth, are very ugly.

Finally, Estländer's plastic has satisfied me in certain localizations, but a correction of the mouth corner had always to follow.

The shape and place of the defect play a great rôle in choosing the method, and its results much depend on the right choice being made.

My plastic consists in taking a more or less highly-pointed triangular flap with the pedicle at the bottom. The flap is taken either from the nasolabial fold, or also extending higher up between the nose and the

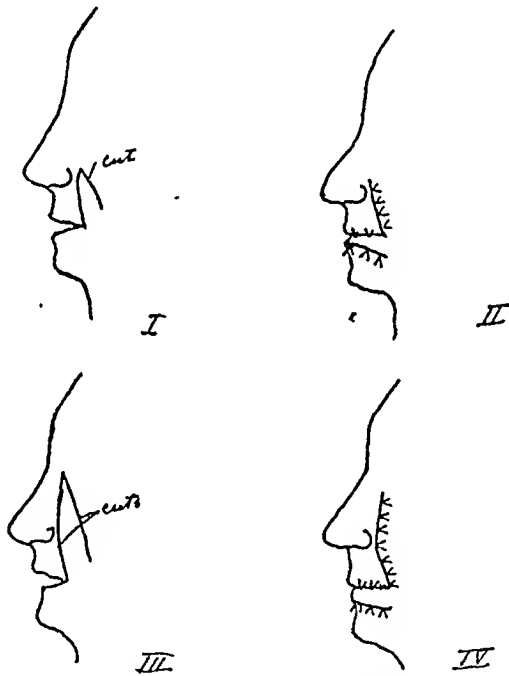


FIG. 22.—The nasolabial flap.

cheek. When requiring mucous membrane the cuts penetrated into the mouth, otherwise more or less muscular tissue was taken in the flap according to the requirements for active movement in the under lip (see Fig. 22). After first completely closing the nasolabial defect, the flap presented itself ready for being placed in the under lip. The flap is used either for a defect or, if the lip be too short or too immovable, is placed in an incision between the red of the lip and the skin.

The advantages of this method are the following:

(1) The flap contains the entire *arteria angularis* (continuation of the *arteria maxillaris externa*).

(2) The flap may, if required, supply excellently functioning muscle

sarily decrease. There is nearly always a way to be found for applying tissue, which can be spared and taken from the immediate neighborhood for covering the defect in a beautiful and practical way. It is still to be mentioned that the procedures of Trendelenburg, Sultan, and Blasius work in a too narrow circuit to produce a sufficiently large and free under lip. The larger the surface over which the tension difference is to be spread without much cutting, the more satisfactory will the result be.

There still remain the plastics of Dieffenbach, Langenbeck, Jaesche, Lexer, Morgan, Israel, von Bruns (two kinds), and Estländer. Dieffenbach's procedure has proved itself to be a very useful, direct, definitely sufficient method, which is mathematically correct; the deficit is divided over a large space, and the flap is well nourished by the *arteria maxillaris externa*. It only has the disadvantage of deforming the cheek. Also the Langenbeck and Lexer plastics, the one with, the other without, spur, satisfied me, in case of very broad, not high defects, in regard to the cosmetic side, but less on account of the bad movability of the new lip.

Morgan's method I would only use modified, as the sewing of the mouth corners is too unnatural; therefore I combined it with my method mentioned below, in cases of complete lip defects, without practising his sewing together the corners of the mouth.

With high and large lip defects, Jaesche's method is the best, only I made the curve cut much wider and higher, so as to keep the *arteria maxillaris externa* in the centre of it. In this way I approached more the Dieffenbach method, and got the advantages without the disadvantages of both, so that the result was both practically and cosmetically good. This operation had arisen by diminishing the cut in my method for the substitute of larger upper-lip-cheek defects described in "Plastic Operations on War-crippled Soldiers with Indirect Usage of Skin of the Neck to Replace Defects of the Face."

The Israel and Lexer plastics with the neck and temporal substitute give (with the favorable healing conditions in defects with bad nourishment, in which cases a plastic from the neighborhood of the defect was not advisable), in general, a disfiguring result. Near the mouth, the new flap contrasts strongly with its surroundings, and the place from where it was taken is closed with difficulty and disfigurement, so that these operations can only be advised in special cases of bad local conditions.

The cheiloplastic after von Bruns, with almost circular incision round the mouth, nearly from one nostril to the other, destroys too many



FIG. 32.

FIG. 33.

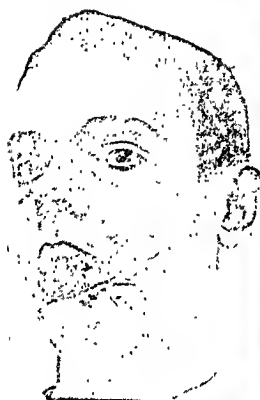


FIG. 34.



FIG. 35.



FIG. 36.



FIG. 37.

FIG. 38.



FIG. 23.



FIG. 24

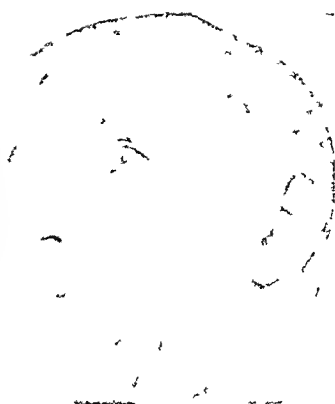


FIG. 25.



FIG. 26.



FIG. 27.

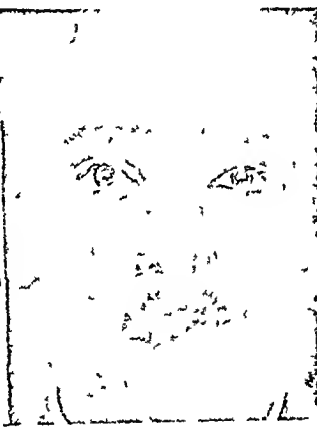


FIG. 28.



FIG. 29.



FIG. 30.



FIG. 31.

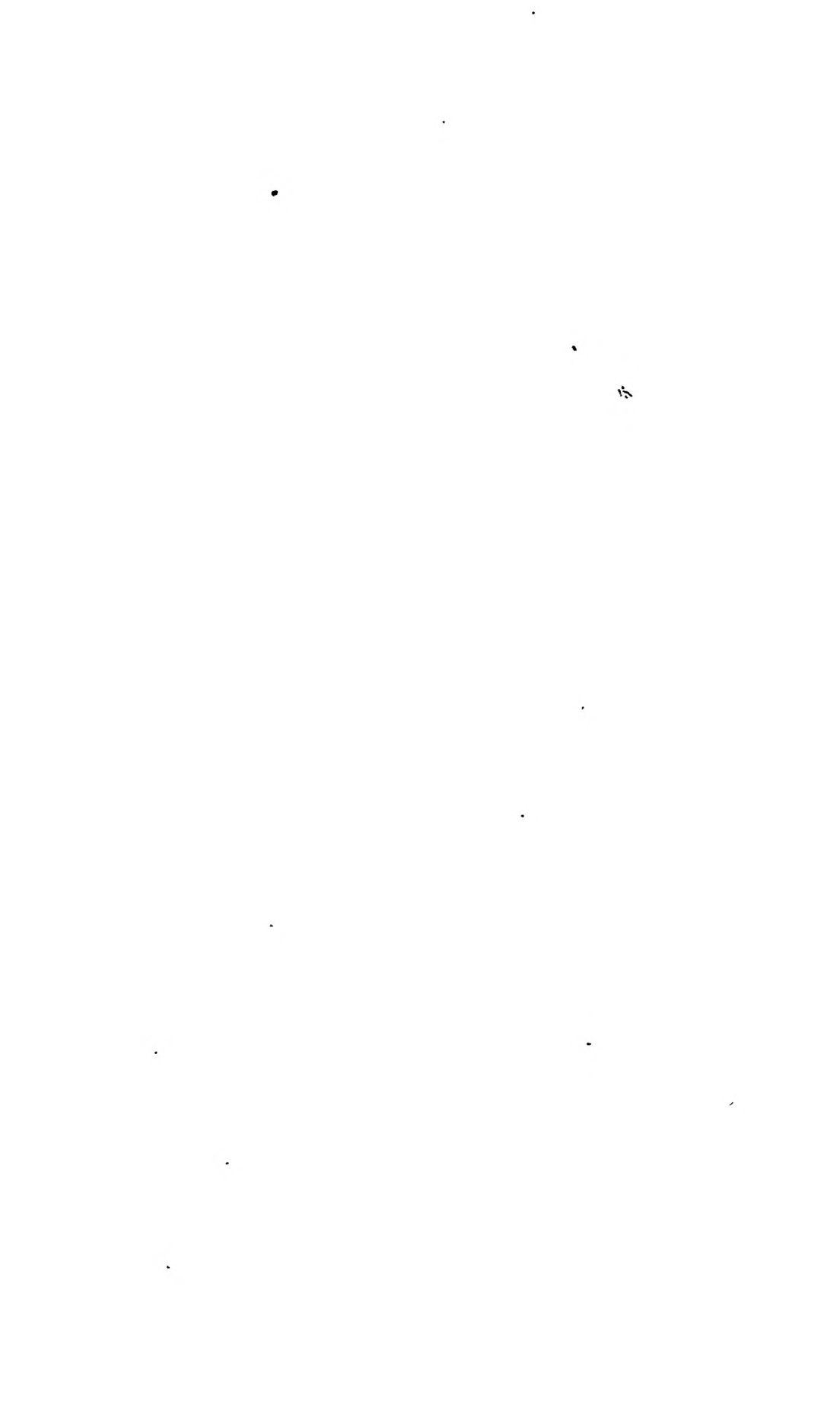




Fig. 39.



Fig. 40.



Fig. 41.



Soldier W. was kindly sent to me for treatment in the Clinic v. Hochenegg, by Docent Dr. Finsterer.

Besides an under-jaw-bone defect, which I also operated (local bone plastic), the patient had a gunshot wound through the left upper and the right under lip. The relatively too large upper lip half was somewhat diminished and drawn by the above described operation, which at the same time raised the under lip and made it more movable (see Figs. 28-31). The remaining prominence of the right upper lip is still to be corrected by a long and deep excision out of its inner side, parallel with the red of the lip.

Soldier D. (Figs. 32-33) (Clinic von Hochenegg). The dentist had made an enlarged mouth by cutting, in order to have more room for his prosthese preparation. Round about the incision there was an extensive growth of scars, so that the left mouth corner was quite immobilized, and, notwithstanding the size of the mouth, speaking, eating and mimic were extremely difficult. The above described mouth plastic corrected them completely. Respecting the protruding of the flap, see remarks on the first patient. The remaining small scars must be removed with the last correction.

Soldier P. (Clinic von Hochenegg) (Figs. 34-37). Here the operation was only a correction after a Langenbeck kind of total under lip plastic, combined with a pedicle flap for mucous membrane substitute. I give here no more details of the first operation but refer to the illustrations. The correction had, as chief object, to make the under lip more movable for speaking and eating; at the same time by lifting the corner, the shape and height of the lip were improved. The patient was not finished after this operation, as the centre of the lip had to be raised. This could be done from the inside of the mouth, as it was caused by the lip having turned inward (entropion), but had not been performed when the last photograph was taken.

Quite another indication was formed with Cadet M., with a very old paresis of the facial nerve. I have also to thank Docent Finsterer for sending me this patient. The same operation was performed, and healed very beautifully, but unfortunately I have only Fig. 38 before the operation and the patient went to the front without being again photographed. The operation had proved its value very well for such cases of paresis.

With the Hungarian soldier M., in the Clinic von Hochenegg, a very successful temporal flap plastic (Lexer) as substitute for the completely missing under lip was made by Dr. Demmer. To correct the too deep immovable under lip he carried out with me a

tissue (muscularis levator angularis) for moving the under lip. (As mentioned above, can considerably improve the Morgan plastic without its corner sewing.)

(3) The sewing together of the secondary defect *disappears exactly in the nasolabial fold*. (Only with very large defects and extensive corrections the flaps extend to near the inner eye corner and then the seam goes higher up exactly in the nose-cheek separating line.)

(4) The upper flap line is sewn together, either with its own mucous membrane (when the flap also contained this membrane) or with other mucous membrane, but *always forms the natural border of the red of the lip*. Only the suture of the much shortened under flap line remains visible after the operation.

(5) In contrast to the somewhat similar method of von Bruns, I can make my operation *either only on one side or on both sides*. In the latter case I have the free choice of the intermediate time. That is because my flap-ends are pointed and easily disappear quite in the lip, while von Bruns's flap-ends are square, and must find another wound edge opposite to join. When I use two flaps (which, however, is seldom necessary) the second flap partly crosses the first. After the complete healing of the first, one has the choice of the size and time of the second operation. It is clear that also the healing is surer than by performing both sides at once.

Here follow some of these mouth plastics made for different reasons.

Soldier D. (Figs. 23-27) (K. u. K. Reservespital Nr. 17 in Vienna), after a shot, had a deep, broadly branched scar at the corner of the mouth, which was drawn much to the side and downward. The scar was deeply spread in the muscles and mucous membrane. The real plastic only followed a preparatory one which removed all the deep scars as far as in the mouth, so that the principal operation could occur later on without entering the mouth. A flap was taken in the manner described, and placed in an incision along the red of the lip.

Of the three seams, only the under one in connection with the little scars of the first preparatory operation underneath it are visible, and can be completely removed later on (see Fig. 37).

As Fig. 37 shows, the flap protrudes a little; this was done purposely, because it is better to be too thick than too thin: First, the secondary defect can be closed more beautifully, when the deep tissue is also removed; secondly, the superfluity of the flap can easily be removed, when after a long time it has not disappeared by the shrinking. A principal thing is that the flap after a long time has enough muscles and does not sink in.

The Thiersch *suitably large and of equal thickness* can only be cut with *regular success* by great practice; one must always get a *tough, perfectly transparent* skin piece, the thinner the better, especially when it must replace the mucous membrane.

*The application of an exact impression of sterilized dentist's impression material and the thorough covering of the same with Thiersch could, after my idea, avoid the dangers and assure a general sure result,* if the mould, covered with Thiersch, were placed in the hollow or in the wound, and the opening were sewn firmly together. I carried out this treatment in 24 cases of different kinds, and the result was (with one exception) that the Thiersch healed *quite completely* and perfectly smooth. In the exceptional case, the mould was taken away too soon from a too small opening, and tore the whole Thiersch away. It was an inlay in the under eyelid, in order to enlarge the shrunken conjunctival sac, and in these cases the inlays require a long time to heal, as the tissue under the eyelid skin is very loose and has a weak circulation. It is very difficult to obtain, and to keep sufficient pressure round the inlay in this special region.

Till now I have operated on seven different types, which number may be considerably increased; the types are:

- I. Enlargement of the conjunctival sac.
- II. Construction of part or entire ear.
- III. Enlargement of the mucous membrane of the mouth.
- IV. Enlargement of the hollow of the mouth.
- V. Plastic of the hard and soft palate.
- VI. Preparation for different skin plastics: (a) Inner covering of flaps; (b) former covering of the secondary defect; (c) for both purposes at once.
- VII. Plastic of the urethra.

I. The enlargement of the conjunctival sac is very often required to make room for the eye prosthesis. In these cases the eyelid skin is then cut parallel with the eye slit, higher or lower according to the case; generally scars must be taken away. And now after lifting the upper part of the cut, an impression can be taken (best with the assistance of a dentist) with sterilized wax material. This after hardening is carefully surrounded in the described manner with very thin Thiersch, which is then placed in the wound, and closed with pressure.

The mould must be made in a manner and with such pressure that its size is such that afterwards, on sewing the wound together, sufficient tension results. Before cutting the Thiersch, which only takes place when everything is prepared to receive it immediately, without first

## PLASTIC SURGERY OF THE FACE

nasolabial flap plastic. Here the flap was very long, was also taken from the nose cheek border and was placed nearly along the entire under lip (see Figs. 39-41).

After this operation the patient could eat solid food which had been impossible before. A final correction should be made to raise the end of the flap and the corner of the mouth. A small nasolabial flap from the left side would do; the symmetry would be easily gained and the movement of the left under lip part would improve.

### III. THE EPIDERMIC INLAY: NEW WAYS FOR SURGICAL PLASTIC BY USING DENTICAL TECHNIC

For a long time many surgeons have endeavored to obtain a skin covering, by laying on "Thiersch" skin pieces in hollows and on wounds. Still for hollows, these measures were mostly not sure of success, and have not been generally applied, though a keen interest has been taken through many good results. I thought the uncertain results could be avoided by improving the technic, as the bad results were caused by the irregular growing together of the skin and the pieces laid on; so that the complete covering resulted, after a long time, by the growing together of the skin islands where the "Thiersch" had attached.

It was a particular disadvantage that meanwhile a shrinking and cicatrizing through the development of scars was taking place in the granulating surface. Therefore I looked for means for applying the "Thiersch" faultlessly even, and under equal pressure, besides avoiding all infection and increase of saprophytes. This is possible by taking a negative impression of the wounds and covering it with one large Thiersch and placing this, under *equal pressure and immovable* for some days, on the wound. The Thiersch must be everywhere of the *same thickness* and *equally stretched* on the impression form, before this is placed on the wound. After creating aseptical hollows, by cutting under the normal skin adjoining the wound, and after lifting and exactly filling up this with an exact mould, completely surrounded with Thiersch (wound of the Thiersch outwards), the *equal pressure* follows by suture in firm tension of the incision. To prevent infection from increase of *saprophytes*, besides scrupulous asepsis, the greatest care must be taken in preparing the Thiersch. This must be very thin, and as far as *possible free from dead cells* which are always infected, and particularly overladen with saprophytes. Therefore I only use the *inner side of the upper arm*, because the skin is thinnest and most elastic there, and I have the part prepared, thoroughly and most carefully, till the skin is *pink* everywhere.

material may do perhaps. In my opinion the white of egg disappears quickly, and gives the possibility of removing the mould after one or two weeks without it sticking to the Thiersch. In the ear case after one week, the stitches are taken away,—the cut is again opened some days later, the mould removed, the hollow quite split from behind, and this cut enlarged above and below, till the flap is so movable that it can be used for a plastic of the ear. We have then two advantages over a direct plastic. First, the flap is already accommodated to its new pedicle nourishment, also the vessels of the pedicle have grown in that time; second, the flap is completely covered with skin at the back, and the place from where it was taken also, so that the conditions are not only advanced, but also clean.

III. The enlargement of the mucous membrane of the mouth often occurs in jaw injuries, or with patients who have retained, after extensive inflammation, scarred contractions of the mucous membrane, as with a patient in the "K. u. K. Reservespital, No. 17," where in consequence of intensive scorbutus, an inflammation of the gum and suppuration of the jaw, with ejection of sequestrum, arose and which healed with such a diminished mucous membrane, that the red of the under lip had grown to the jaw everywhere, and the entire fornix, on the sides, as far as both masseters had disappeared. In this case I made a vertical incision in the skin of the middle of the under lip, under the red part, and prepared from there to the left and right under the skin, in 3 inches depth and more than a thumb width, two hollows, which were filled with stents covered and stuck with Thiersch in the manner above described. A fortnight after, a cut was made inside the mouth, from one masseter to the other on the thinnest covering line of the stents, first with the knife, and after removing the inlay, the cavity was laid quite open with the scissors, which of themselves find the thinnest line of the cut. An impression of the under jaw was immediately taken, which had naturally not been possible before the operation, as one could not get down to the front surface; and immediately afterwards a prosthese was constructed (with all the teeth, which had been lost in consequence of the illness) and placed in the mouth. The under lip, which had formerly been perfectly immovable, had at once regained its use, both for speech and mimic. In other cases where the upper and under lip were curled inwards, the inlay was placed parallel with the mouth orifice, the same also removed after making a parallel cut in the mucous membrane. At both ends mobilization cuts were made so that the cavity formed could spread itself in an epithelial surface.

placing it in a physiological solution, the hard mould must be placed in the hollow and the incision pressed together with the fingers, to see if the tension is correct, otherwise the mould can be altered. It is not practical to enlarge it by adding to it, as the join leaves a line where the Thiersch later on falls in, but it is better to make a new mould if the first prove too small. It is possible to decrease the size, if too large, by cutting before it is quite hard, and softening down the cuts.

The closing under pressure by the sewing is necessary for two reasons—first, the Thiersch is pressed everywhere for quick healing, and second, possible bleeding is prevented. Though I construct the hollows by *cutting* on purpose to open the most possible number of little blood- and lymph-vessels (by all free transplantations I prefer this method to the blunt preparation in general use, because it gives better healing condition). By sewing together under pressure, the small vessels are all closed—only the large arteries must be squeezed or twisted, but not tied, as no foreign substance may remain between inlay and wound. In consequence of the pressure a primary healing of the suture is not sure, but mostly of less importance, as an ugly scar can be easily corrected afterwards. After about two weeks the conjunctival sac is cut parallel to the eye split, and at such a distance from it where the inlay is nearest to the surface. The mould is removed, and the smoothly healed hollow is annexed to the eye-hole in order to receive the eye-prosthesis, which must be placed directly, that the still elastic hollow can adapt itself to the prosthesis form. It is now clear that the hollow must be constructed everywhere as near as possible to the mucous membrane (see Figs. 42-44).

II. With ear defects, a longer or shorter cut, according to the size of the defect, is made exactly along the hair growth, behind the ear. The skin in front with the periosteum is raised with the raspatorium, as far as the ear, and above and below the cut as required for the defect. The mould of dentical mass (Stent's) of this hollow, after hardening, is completely covered with Thiersch and placed in the hollow. The wound is then sewn together under pressure.

In all cases of this method it is important that the bottom of the wound is made as flat as possible that the Thiersch can be laid quite smoothly on the mould—and as the thin skin is very elastic this can be done without folds, though a fold would not prevent success. In very difficult cases I stick the Thiersch on the mould, and especially when deep tunnels with small openings are to be covered with epithelium, and where the mould with Thiersch must be pushed in with difficulty and under pressure. I stick with white of egg, but other



FIG. 50.—Patient with a maximal filling of the hollow with gauze in order to show its size.



FIG. 51.

FIG. 52.

FIG. 53.



FIGS. 51, 52 and 53.—Patient finished—the centre of the under jaw being replaced with a rubber lump of desired size and fixed in the definitive dential prosthese.



FIG. 54.



FIG. 55.



FIG. 56.



FIG. 42.



FIG. 43.

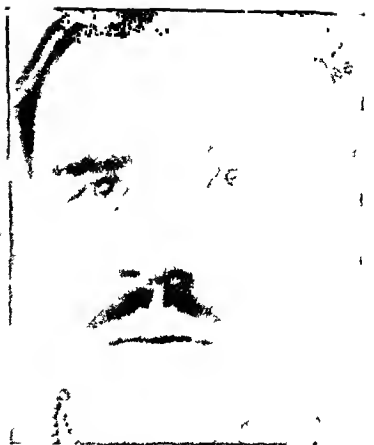


FIG. 44.

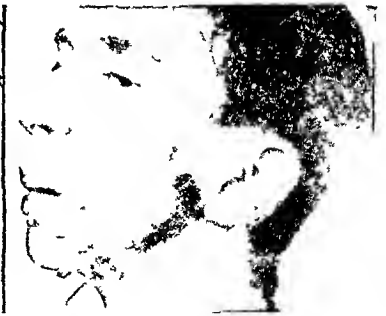


FIG. 45.

FIG. 46

FIG. 47.

FIG. 48.



FIGS. 47 and 48 —Showing the procedure of "epidermic inlay," with the stents piece and the opened hollow entirely epithelized.

FIG. 49.—Patient after being operated (removing all scars and making the epidermic inlay). The sutures are not yet removed.





FIG. 61.



FIG. 62.



FIG. 63.



FIG. 57.

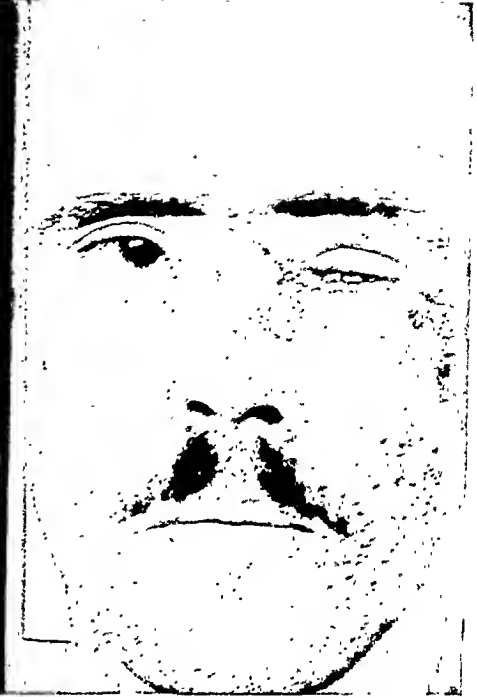


FIG. 58.



FIG. 59.



FIG. 60.

The mode of procedure is in a similar way as by Lane, but again more advantageous for the two reasons already mentioned in the ear plastic. First, on turning flap the same is everywhere skinned over and also the place from where it was taken, and besides the mouth clean. Second, for one or two weeks the flap has become accommodated to its new nourishment conditions, and the same has improved in the pedicle. In this interval the flap had no chance of shrinking or becoming infected, as in the procedure proposed by many surgeons, to perform the Lane operation in two instead of one treatment. Neither can granulations develop and cause later shrinking, which would in any case influence later the nourishment conditions and reduce the resistance and the bone growth of the periosteum flap.

According to the size of the defect, one makes at a greater or less distance from the defect, a curved cut on the processus alveolaris, through the gum and periosteum, raises it with the raspatorium, takes the impression, etc. In the second operation, after one or two weeks, the seam is again opened, enlarged above and below, till the flap is sufficiently mobile (naturally as little as possible, as the nourishment does not come from the centre of the pedicle but from the upper and under side, *vide* anatomy), then cut along the edge on the other side of the defect, and undermine till the turned flap, without being diminished, can be quite taken up (Lane). Then follows excoriation of both sides of that part of the flap which is to lie in the new wound and to be completely covered, then stitched. The sewing is in such a manner that the stitches which fix the turned flap edge into the depth of the wound are in pretty parallel line with the slit in palate. The second seam connects the free-made cut edge to the massive part of the over-turned flap.

Dr. Demmer (at the present time chief assistant in the clinic v. Hochenegg) has also successfully carried out my method, even in a very wide, totally double-sided slit of hard and soft palate.

V. The preparation of skin plastics has, first, the purpose of providing a flap with an inner covering of Thiersch where it has to cover a cavity, viz., in noses, eyes and mouth, second, for previous epithelialization of the place of removal of the pedicled flap, and, third, very often when wishing to combine simultaneously both the mentioned purposes. Such was the case with First Lieutenant K., in the clinic of v. Hochenegg, where a nose skeleton and soft part defect lay in the middle of the nose. Here, over the defect, an "epidermical inlay" was placed so that the pedicled flap, before being turned, received a skin covering on the inner side (Figs. 54-58).

## PLASTIC SURGERY OF THE FACE

IV. The enlargement of the mouth cavity is often necessary in normally large mucous membrane surfaces, if the tongue is so scarred at the front base as to affect speech and swallowing. In the same way as with the eye and ear plastics of this system, after removing the scar, a cross cut is made and a space formed, which is filled with stents mould, covered with Thiersch and then sewn together. Here also as with all such intra-oral plastics (contrary to my usual practice in order to avoid as far as possible the antiseptic), I have followed Professor Weiser's most emphatic advice, and put a layer of iodine gauze between the stents and the Thiersch. I have been very satisfied with the result. A still more frequent occurring indication lies in large bone defects of the centre of the under jaw, the so-called "bird face."

By cutting the outer skin, all inner scars in the case depicted in Figs. 45 and 46 (F., K. u. K. Res. Spit., 17, Vienna) were completely removed, and besides by internal enlargement, always working through the outer cut, a cavity was formed by pushing the jaw pieces apart, which when filled up under pressure presents normal anatomical conditions to the jaw line. This is not always possible without cutting the mucous membrane in vertical direction. When the elasticity of the membrane cut allows, this is sewn together horizontally, otherwise closed with a flap or left open, as an uncovered epidermical inlay, even in the mouth, may heal, but is not quite certain. After filling the cavity with stents mould, covered with Thiersch, ten days later this piece is removed, after cutting on it in the inside of the mouth. The cut enlarged with the scissors, as described above. Then the dentist, who must be present, takes an impression and quickly prepares a temporary prosthesis without teeth. This must be exchanged later for the definite prosthesis with teeth. This prosthesis has to perform the following uses: To fill up the cavity, giving normal anatomical lines, and to support and connect, as in one piece, the jaw. The patient then looks quite normal and can always submit later to a bone plastic, whereby the soft tissues through their stretching and accommodating themselves to normal position offer better conditions for a bone plastic than was before. I speak here of patients who refuse a bone plastic, or of those who do not at present come into consideration. I show Figs. 45-49 of the proceeding so as to make easier to understand the method.

In palate plastics, particularly on hard palate defects, even of very large dimensions, this proceeding is of great value, as it not only considerably improves the prognosis of children born with divided palates, but also makes operations on very great defects possible, which were formerly considered practically inoperable. Case R, which I operated in the clinic of Professor Onodi (Budapest), belongs to the latter.

least tissue possible there, so that only a very thin layer of the same must be cut; for this cut surface is not epithelialized and with time could become a very large scar.

Also the back part of the cavity must be as straight as possible, that the Thiersch may more easily be laid round the mould without creases. Of course the back of the mould must be laid in the centre of the Thiersch. The space should in a certain measure be funnel-shaped, that the first and last impression may be removed, and the skin-covered mould can be pushed in. Although a perforation of the wall must be carefully avoided, the Thiersch can bear much, and always heals quite smooth, even near chronic suppurations which are only dispersed with difficulty. I never saw a rise of temperature in the whole of my 24 cases. Once, in one case a necrose appeared on a very small part of the flap edge, and even the Thiersch round about it healed completely on the flap.

(2) The skin should be prepared only with tincture of iodine and careful avoidance of any other moisture. The skin is to be freed of all dead cells by thorough shaving, without soap or moisture, and then the Thiersch cut equally very thin, in one piece of the necessary size. It is important to cut the Thiersch only when its reception in the cavity can take place immediately, that this (as I rarely lay it in a physiological salt solution) can be laid at once around the mould and does not dry up on its wound surface.

(3) The mould should be very exact, and so large that the edges of the wound can be brought together, although it is of no essential disadvantage if the seam gapes even in the beginning.

(4) The stitches must be strong, and deeply taken so that they do not tear too soon.

(5) One must have patience before beginning the second operation; especially with tissues which are vascularized badly and are flaccid, for example the eyelids, so that they do not remain stretched over the mould, but will expand and slacken. With good technic the "epidermical inlay" is a sure procedure which may be still further used for new groups.

The seven named groups are all represented in my operations, but this method can be applied in many other cases, *e.g.*, for covering bone cavities, soft part defects; if a mould covered with Thiersch is put on the wound and pressed and fixed there, instead of being sewn. Professor Weiser used this variation of my method with good result for covering wounded surfaces inside the mouth. To keep a constant pressure with the mould on the Thiersch, he perforated the mould as well

## PLASTIC SURGERY OF THE FACE

Another case, R., in the K. u. K. Reservespital, Figs. 59-62, had a large under-lip defect. With this patient three chestnut-sized inlays were made; under, to the right and left of the defect, but not only to cover the inner part of the flap, but also under the chin to cover a secondary defect which would arise there.

VI. For strongly pronounced hypospadia this procedure is quite suitable, as shown in two cases in v. Hochenegg clinic, where in one case the urethra opened in the centre of the cloven scrotum. Finally, by pretty complete urethra plastic, I have applied an apparently similar, but in reality quite different, treatment. Instead of creating a cavity, or in this case a tunnel in the desired form, to take an impression of it, etc., I followed the contrary proceeding, which is not to be recommended except in this case. It would have been technically most difficult to take an impression of so long a tunnel without splitting the outer covering. Therefore I previously took a very wide rubber drainage-tube, 8 inches long, and made the tunnel freely according to the size of the tube. From a little cut on the perineum, a tunnel was made chiefly blunt under along the scrotum to the end of the præputium, by first pushing a trocar, then always thicker blunt instruments, till finally the handle of an elevatorium passed through the whole tunnel. It is clear that this work is more incorrect and in general cannot compete with the above-mentioned method; yet in this case I succeeded completely. I may mention that I split the rubber tube lengthwise, covered it with white of egg, let it dry, then cut the Thiersch in one piece, dried the same on the outer side of the skin, laid it along the tube so that the overturned parts joined on the split and were brought in and hidden in it. The result was a perfectly smoothly covered drain-tube, the Thiersch stuck on it with white of egg, and besides the edges were held fast in the split which had the inclination to close together; when introducing the tube into the tunnel the possible danger of rubbing the skin off the tube, which increases with the greatness of the pressure round the tube, will also diminish with it as the split is more firmly pressed together, and keeps the skin in its place. Also in this case (clinic v. Hochenegg) the flap, which was 8 inches long and 2 inches broad, healed completely. (See Fig. 63.)

By this method the following points are to be especially borne in mind:

(1) Correct choice and formation of the cavity, where care must be taken that when later on this is to be opened elsewhere, for instance, in the inside of the mouth, the epithelialized cavity has, as covering, the

# TRAUMATIC ANEURISM OF THE TEMPORAL ARTERY\*

By J. SHELTON HORSLEY, M.D.

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A TRAUMATIC aneurism, according to Matas, is an aneurism that results from a trauma to a healthy artery. It is not very common and should not be confused with the so-called idiopathic type of aneurisms that occur in diseased arteries. Sometimes in the idiopathic type there is a history of a slight trauma or strain which precedes the formation of the aneurism. However, such an injury, which would be insufficient to damage a healthy blood-vessel but will produce an aneurism in a diseased artery, is not the chief etiological factor. It is only when traumatism is the sole cause and when the blood-vessel was healthy up to the time of the damage that the resulting aneurism can be termed traumatic. Instances can be imagined in which injury to a healthy artery may produce a weakening of some of the coats of the vessel and cause a pouch formation somewhat similar to the protrusion of an inner tube when the outer tire has given way, but, as a matter of fact, probably all traumatic aneurisms are caused by a direct arterial injury that results in a hæmatoma. A true traumatic aneurism, then, may be described as one that results from the organization of a hæmatoma produced by an injury to the wall of a healthy artery.

What probably takes place is that the trauma produces a rupture of the artery, and an extensive hæmatoma is formed, which by its pressure prevents further bleeding, but the force of the arterial stream produces a pocket or lake in that portion of the hæmatoma nearest the injured artery. This lake becomes lined with endothelium, and later a supporting framework of connective tissue, corresponding to the adventitia of the blood-vessel, is gradually formed while the rest of the hæmatoma is being absorbed. In most instances where a healthy artery is ruptured, the patient either bleeds to death or the artery is occluded by a thrombus from the pressure of the hæmatoma. It is the exceptional case in which one of these things does not occur, and here a traumatic aneurism forms, unless an injury to a vein causes a communication with the vein. We can merely speculate why it occurs at all. In dogs, where clotting of blood is very prompt, it is practically impossible to produce a traumatic aneurism. In man several conditions may promote it: the injury to the artery may be done in such a manner

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\* Read before the Southern Surgical Association, December 12, 1916.

## PLASTIC SURGERY OF THE FACE

as the cheek with a kind of flat-headed nail, head in the mouth, and the projecting end was previously prepared to hold a nut, which pressed against a perforated plate, between which and the cheek iodine gauze was wrapped so thickly that the mould was firmly pressed on the Thiersch. The whole construction was very fine and functioned very well.

To make an outward auditory passage, this procedure can be used to prevent two parts from growing together, or to prevent definitively an existing growth. With penis skin or vagina plastics, even with bladder plastics, also rectum plastic, *e.g.*, when after extirpation of a rectum carcinoma an anus sacralis is laid on, the removed piece of intestine can be replaced by an epithelized cavity, which when perfectly ready, is bound on the one side with the central rectum piece, on the other with the sphincter, if it is still left—if not, it can be combined with a sphincter plastic (Schoemaker or other methods).

With carcinoma œsophagi the upper part of the œsophagus can be connected with the stomach with the "epidermical inlay" outside the chest, instead of the usual skin plastic, which is less sure.

In general the Thiersch application as substitute for mucous membrane has an important advantage, as the Thiersch accommodates more easily to the mucous membrane conditions, and undergoes a kind of successive membrane transformation, than is the case when using the entire skin with its complete skin formation, glands, etc. The skin in such conditions goes through a long stage of inflammation or eczema, while the Thiersch only shows particularly strong scaling in the mouth and eye cavities at the beginning.



GEO. H. EDINGTON (*Glasgow M. J.*, 1903, lx, 213) reports the case of a boy fourteen years old, who was wounded in the right temple by the bursting of a soda-water siphon. There was a small punctured wound which bled profusely. One stitch was taken to stop the bleeding. Several days later a pulsating swelling appeared where the temporal artery crossed the right zygoma. It was spherical, about three-quarters of an inch in diameter, and presented expansile pulsation. On the apex of the swelling there was a small wound almost healed with a stitch in it. The aneurism was operated upon, the artery being ligated above and below the sac, and the sac excised. It contained a dark clot which on removal left a smooth interior of the sac that communicated with the temporal artery by a small aperture.

H. MORESTIN (*Bull. et mém. Soc. anat. de Par.*, 1912, lxxxvii, 420) reports a traumatic aneurism of the temporal artery in a patient forty years old who was injured in the right temporal region as a result of an automobile accident. The bleeding was arrested by compression and dressing. Several days later a small round mass formed under the scar and gradually increased in size. The skin appeared normal and could be moved over the growth, which was about the size of a large pea. There was distinct pulsation, synchronous with the radial artery. The aneurismal sac was excised after ligating the artery on both sides of it. The sac when removed had a cavity with uniformly thickened walls into which the ends of the artery opened. It involved the frontal or anterior temporal branch of the temporal artery. According to Morestin, aneurisms of the small superficial arteries of the head are very rare.

E. HOLZWARTH (*Pester Med.-chir. Presse*, 1915, li, 64) records the case of an officer who, in August, 1914, received a gunshot wound. The projectile penetrated the middle portion of the left zygomatic arch, the point of exit being on a level with the auditory canal behind the ear. He lost much blood and a large hæmatoma formed in front of the ear, which evacuated itself a few weeks later through the external auditory canal. Since then he noticed constant blowing sounds that increased on exertion. Three months ago there was marked dilatation of the temporal artery and its branches. The temporal artery was dilated cylindrically in front of the ear. There was pulsation and a blowing bruit. The upward branches were also dilated. Holzwarth demonstrated the case as one of unusual rarity, a case of aneurism of the temporal artery from a gunshot wound.

At the same meeting DR. THEODORE HÜLTI presented a patient who had six weeks previously sustained a contusion of the head from a fall. Five centimetres from the outer angle of the eye there developed an increasing tumor with fluctuation and pulsation.

The following two cases of traumatic aneurism in the temporal arteries which have occurred in my practice were both in youths whose previous health had been good, and in whom there was no history of either acquired or hereditary syphilis. As the aneurisms in both cases followed severe traumatism, which at once produced large hæmatomas, they may be taken as examples of traumatic aneurisms in previously healthy arteries:

## TRAUMATIC ANEURISM OF THE TEMPORAL ARTERY

that a flap of intima is formed; a hæmatoma may occur in such a way as to produce a mechanical effect on the blood stream that is most likely to cause an eddy; or there may be a deficiency in the elements of the blood or tissues that produce prompt clotting. The rarity of these conditions evidently accounts for the uncommon appearance of traumatic aneurisms even in exposed vessels.

The temporal artery, or as it is called by Gray, Piersol and others the superficial temporal artery, is one of the two terminal branches of the external carotid, and though smaller than the internal maxillary, the other terminal branch, its course is practically a continuation of the external carotid; consequently, it receives the full force of the direct current. The temporal artery begins in the substance of the parotid gland behind the neck of the condyle of the lower jaw, crosses over the root of the zygoma lying on the temporal fascia, and divides about two inches above the zygoma into an anterior and a posterior temporal branch. It gives several branches from its main body, twigs to muscles and to the parotid gland, the transverse facial, middle temporal, orbital, and anterior auricular. The anterior temporal runs tortuously upward and forward on the forehead. The posterior temporal, which is somewhat larger, curves backward and upward along the side of the head. The temporal artery itself and its terminal branch, the anterior temporal, are very superficial and are much exposed to trauma. The posterior branch is usually protected by the hair and a hat or cap. The temporal artery and its continuation, the anterior temporal, lie close to the skull, and rest on the temporal fascia and pericranium of the skull throughout most of its course. A blow upon either of these arteries would drive it against the skull with but little protection of soft tissue either over the artery or under it. It seems remarkable that serious injuries to these temporal vessels are not more frequent, especially in children and athletes where bumps and blows on the head are such common occurrences.

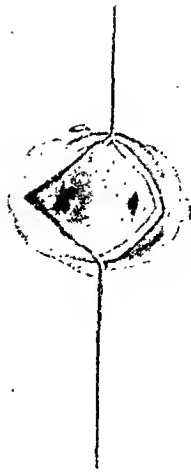
Since 1896, during the past twenty years, a rather thorough search of the literature has shown only five cases of traumatic aneurism of the temporal artery and its branches. A brief abstract of these follows:

O. MANZ (*Beitr. z. path. Anat. u. z. allg. Path.*, Jena, 1898, xxiv, 531) records the case of a sailor twenty-five years of age who received a blow from the fist in the right temporal region, and two years later examination showed a small globular tumor under the skin. The tumor had developed during the past two years and had attained the size of a hazel-nut. It pulsated distinctly. It involved the bifurcation and upper end of the right temporal artery. The sac was excised after ligating the arteries on each side of the aneurism.





FIG. 1.—Drawing showing the location and appearance of the traumatic aneurism in Case I. The aneurism involves the first part of the anterior temporal artery.



Melen Lorraine, Jr.

FIG. 2.—The sac of the aneurism in Fig. 1, after its removal.



FIG. 3.—Case II, showing the traumatic aneurism of the temporal artery.

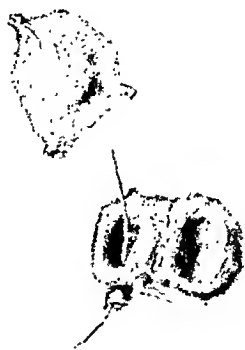


FIG. 4.—The sac of the traumatic aneurism in Fig. 3, after removal.

# THE TREND OF SURGERY IN EMPYEMA OF THORAX\*

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It is characteristic of modern operations that they conform more and more to a constant type. The operation for empyema of the thorax, however, thus far, has been "variant" rather than "constant."

The precision attained in intra-abdominal operations and the resulting efficiency therefrom was evolved from exploratory incisions. It therefore lay in the nature of things that when analogous methods were applied to intrathoracic conditions, greater efficiency in results would also become prevalent. That thought but fleetingly suggested itself to the minds of several pioneer workers in intrathoracic surgery. By and large, empyema, acute and chronic, is the most common thoracic pathological condition demanding surgical relief. Yet the operation for empyema, strange to say, was not forthwith slated for the benefits that followed the newer methods of intrathoracic exploration.

The early recognition, the correct method of attack, the abbreviation of hospital internment, lower mortality were always engaging topics for discussion in acute empyema, and the climax was attained in the controversy that has waged to this day, in the cure of relapsing empyema and the thoracic fistula, by the operations, overwhelming for the patient and surgeon alike.

Dr. Howard Lilienthal's impressions constitute the most advanced thought on the topic under discussion. Little more than a year ago, at the American Surgical Association, June 11, 1915,<sup>1</sup> he said, "In my other thoracic work, I had noted the wonderful exposure by wide rib retraction through a long intercostal incision, and I adopted this operative principle as a primary evolutionary move, etc." This it should be noted is a precise enunciation of a principle visualized and executed and bids fair to mark an era in coping successfully with empyema in a constant way.

The older operative procedures familiar to all surgeons preclude

\* Read before the Surgical Section, New York Academy of Medicine, December 1, 1916.

## TRAUMATIC ANEURISM OF THE TEMPORAL ARTERY

CASE I.—H. G. P., aged nineteen years, white, male. Family history has no significance.

The patient has had the usual diseases of childhood; also pneumonia and typhoid fever. He was well nourished and in good general health. He had never had any venereal disease, and there was no history of hereditary syphilis.

While playing basket-ball in November, 1914, he was struck in the right temporal region. This was followed by very marked swelling which gradually disappeared. The skin was not broken. A few weeks later a small circumscribed growth about the size of a buckshot appeared on the right side of the forehead, about two inches above the zygoma. Pulsation in the growth was soon observed. It gradually grew until it became about one-half an inch in diameter. Since May 1, 1915, the pulsation has been more marked. Operation was done June 12, 1915. An incision was made under novocaine, and the sac dissected out. The artery was ligated above and below the aneurism and the aneurismal sac excised. It seemed to be in the first portion of the anterior temporal. The patient left the hospital two days after operation. There has been no recurrence.

CASE II.—E. M., aged nine years, white, male. There was no history of syphilis in either parent. There were two children, both healthy. There was no history of miscarriages in the mother. The boy has had the diseases peculiar to childhood. He was operated upon for adenoids four years ago. In March, 1916, while wrestling, he was struck on the left side of his head by a boy's shoe heel. Considerable swelling followed which gradually disappeared, and a small lump formed just above the zygoma on the left side. No pulsation was felt in this lump until May, 1916. After this time the growth, which was about one-half an inch in diameter, began to pulsate. On exertion the pulsation became so marked that it was disagreeable to the patient. Operation was done under local anæsthetic on May 26, 1916. A transverse incision was made and the aneurismal sac was excised after ligating the temporal artery below and above the sac. There were three arterial branches from the sac. The sac sprang from the temporal artery just above the zygoma. It contained a small clot which was partly adherent. The patient left the hospital the following day, May 27, 1916, and made a satisfactory recovery. There has been no recurrence.

It is very patent that Sauerbruch endeavors to make out a case for the "Differential Pressure Chamber," whereas between the lines may be read that the expansibility of the lung is fundamental.

Now the Delorme-Fowler operation of decortication with Ransohoff's modifications, too, is based on the expansibility of the lung, after it is freed of the constricting exudate. But perusal of the cases so operated upon discloses that this happily conceived operation repeatedly fell short of its mark, we believe, because the method of approach through a trap-door incision was inadequate to the proper performance of the same in every instance: and when executed by multiple rib resections, as suggested by Lloyd, the operation for empyema was a combined thoracoplasty and decortication.

All of the remedial measures for empyema of the pleura are essentially decompressing operations: that is to say, decompression of the lung with the incident restoration to normal or obliteration of the interpleural space and elimination of any dead spaces. A due appreciation of this objective is what we aim to effect in advocating the abandonment of the categorical rib resections with the cut-and-dried tube drainage of empyema.

Over our predecessors in this field of work we have the immense advantage of the use of X-rays. We have come to regard the aid of X-rays as a "*sine qua non*." In every instance, save where the urgency of the situation precluded (such as great intrathoracic pressure) and also where, owing to the lateness of the hour, X-ray service was not available, all patients were X-rayed. Most valuable information as to location and extent of disease and point of attack, type of operation and prognosis were at once turned to account. Guided thus by the X-ray findings in all instances, a preliminary confirmatory puncture and aspiration is performed just prior to the performance of the operation. On the other hand, we would emphasize that diagnostic exploratory punctures be abandoned at the bedside, in favor of the confirmatory puncture constituting as the latter does one of the steps of the operation.

In the case of very sick patients, particularly young infants, an aspiration alone may constitute the first step of the operation, to be followed forthwith, or at the earliest opportune moment, by the simplest possible tube drainage through an intercostal space. The skin anæsthetized by ethyl chlorid spray or novocaine 1 per cent. is incised amply to permit intercostal puncture with trocar and cannula; and advancing a 20 F. catheter, with several openings at the tip, for a very short distance through the cannula, which is now removed. Uniformity of drainage other than siphonage while the tube was in place in the

their mention. This comment alone, however: that the multiplicity of methods of dealing with acute empyema so often the forerunners of chronic empyema and fistula and the variegated plastic operations for their cure, constitute the most damaging testimony to the lack of satisfactory routine.

In a very searching article on "Surgery of the Chest,"<sup>2</sup> Kuttner (1912), speaking of thoracotomy, says, "That for purposes of evacuation of pus in the chest, thoracotomy has passed into the background, whereas rib resection occupies the centre of the stage, and that the simple intercostal incision is only an emergency procedure practised where the operator has not the necessary instruments at hand, or is not conversant with the technic. While thoracotomy for evacuating pus is decidedly waning, thoracotomy for the exposure of thoracic viscera, with the aid of differential pressure and perfection of asepsis, is rapidly gaining ground. These latter thoracotomies are effected with a large incision."

By this last remark Kuttner's injunction against thoracotomy for empyema falls to the ground, since his conclusion is erroneously based on a comparison of small thoracotomy versus the large. And we would add in the light of our experience that the intercostal incision is not an emergency procedure, and that for its proper execution, it also requires proper instruments, as will be referred to later on.

Elsewhere Kuttner reverses himself in his endorsement of Sauerbruch's endeavors to cure recent empyema, *with thoracotomy*, without drainage tubes under differential pressure, after as well as during the operation. Sauerbruch reports several successes. It is of interest to cite the procedure of Sauerbruch: "Under differential pressure the lung expands and forces the pus to escape through the thoracotomy wound. All pus is thus evacuated at one stroke and the surface of lung expanding comes in contact with the chest wall. No drainage nor tamponade, and air-tight gauze dressings were changed after three to four days in pressure chamber. In two uncomplicated instances, the lung was adherent to the chest on the sixth and seventh day. Subsequently two to three weeks more may be required to heal the granulating wound. Such ideal healing does not always ensue. Often the lung does not yield by expanding readily to the intrabronchial pressure and a few more dressings may be required."

But with all that Sauerbruch is of the opinion that the course of healing is abbreviated and less complicated than usual. The procedure has the endorsement of Kaush, Karewski, Heller, Goebel, Wendell and Hoffman, also in chronic empyema.



has disappeared. Following "minor thoracotomy" there is never any necrosis of the ribs nor bony bridges from regenerated periosteum after complete healing, and the resultant cicatrix is cosmetically less obtrusive, and it is by no means to be overlooked that the scoliosis following rib resection rarely if ever makes its appearance.

Encapsulated empyemas are in a class by themselves, and wherever diagnosticated in advance by X-ray are treated by resection of one or more ribs, inclusive of the periosteum and the abscess cavity tamponated.

*Drainage.*—If the thoracotomy be large enough, drainage without tubes, gauze or rubber dam is as effective as with rib resection; and, when drainage appears to be inadequate, the cause therefor lies deeper, intrathoracically, such as interlobar collections, those between diaphragm and lung, or even juxtacardial or intrapulmonary abscess or bronchiectasis. All of these can be attacked through an enlarged thoracotomy "en route" to the performance of the "mobilization." Drainage was effected by inserting as short a tube as possible, and its removal at the earliest moment, guided by defervescence and diminished secretion, eventually controlled by X-ray examination. In the thoracotomies of larger dimension often no drain whatever was employed, or at the most, a small piece of rubber dam. In adults the more powerful vacuum suction pump was intermittently applied only to evacuate the pus, and where called for posture most favorable to the freer flow of pus was assigned. Lung expansion was fostered by forced respiration with James's bottles or blowing up balloons, and roof dwelling was reserved for the more debilitated patients. Also mild physical exercises were instituted.

From the aforesaid it follows that routine has given way to rationalization of treatment in empyemata. This implies availing ourselves of all resources, operating strictly according to indications, attaining thereby greater efficiency as witnessed in quicker healing; lessened hospital domicile; lessened number of operations; less mutilation; *no operative deaths*, and a somewhat lower total death-rate by 5 per cent.,<sup>4</sup> which we hope still further to reduce. The thoracic fistulæ and thoracoplasties, alike so mutilating and so mortal, and which used to be so numerous, much to the discomfiture of all statisticians (those of Dr. Wilensky placed at 23 per cent.), have been completely eliminated. Thus we believe to have fulfilled the longing for an improvement culminating in this signal gain—the passing of thoracoplasties. The late recognition of empyemata is due to inherent difficulties of diagnosis and is accountable for their tardy delivery to the surgeon and the resulting untoward results in so large a number.

small wounds, particularly in children, was facilitated by some form of negative pressure.

The apparatus suggested by Perthes<sup>3</sup> on the lines of Sprengel vacuum pump system permits separate collection of pus. As the amount of pus diminishes and changes to a serous character and the temperature falls, the tube is removed. A departure from such normal convalescence calls for an X-ray, on the findings of which further operation may be predicated, such as minor intercostal thoracotomy, which we choose to so designate, to distinguish it from the added features which characterize the "major thoracotomy" and "lung mobilization." Detailed features of these have been elsewhere mentioned originally by Dr. Lilienthal and subsequently in a joint publication.<sup>4</sup>

In his recent report of 300 cases heretofore operated on in the various services of Mt. Sinai Hospital, Dr. Wilensky<sup>5</sup> emphasized that rib resection was the routine. In our cases, minor thoracotomies preponderate. This should not signify any vindication of nor identity with the older practice of intercostal incision. Minor thoracotomy actually came to be a matter of incidence as a preliminary step in the development of the operation herein designated "Major Thoracotomy" and "Mobilization of the Lungs." As a retrospect covering two years' work in unselected cases, totalling nearly one hundred, these addenda are offered.

The proper posture for a good exposure to facilitate the operation is of the greatest importance. It is managed by placing the patient directly on the sound side, if local anæsthesia be employed; but under general anæsthesia the patient should be placed on the abdomen. In the lateral posture, the tilting of the trunk to either side of the table is obviated by flexing the thighs as in Sims's position with a pillow between the knees, and thus, with the aid of the pillow or the adjustable bridge of the table in the iliocostal space, the trunk is forced into scoliosis. The division of the chest wall should be executed with great expedition so that most of the time be available for intra-thoracic work.

With thoracotomies, minor and major, hemorrhage from intercostal vessels is obviated by cutting close to the upper margin of the lower rib; next there is no delay in isolating the vessels for ligature, with the incident risk of slipping of the same and secondary hemorrhages. Abandonment of routine rib resection materially shortens the operative procedure and lessens shock; the wound conditions are simpler, and healing is very much more prompt, since the complication of sinuses dependent on the osteomyelitis of one or more resected ribs

THE PROGNOSTIC AND THERAPEUTIC SIGNIFICANCE OF  
SKELETAL METASTASES IN CARCINOMA OF THE BREAST\*

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THE operative procedures for carcinoma of the breast as elaborated by Willy Meyer and Halsted in the United States, Rotter in Germany, and Handley in England, increased considerably the chances for a radical cure of the disease. Indeed, in its early stages, according to the statistics of Halsted, fully 85 per cent. of the cases remain well for the period of three years after the operation. Nevertheless, even to-day the ultimate results obtained with the most radical methods of surgical treatment of carcinoma of the breast are far from being satisfactory. The reason for this lies in the difficulty in having the patients submit to the operation in the early stages of the disease.

It is impossible to form a perfectly correct estimate of the true therapeutic value of the radical amputation of the breast for carcinoma, since in the majority of the publications the authors do not state the percentage of cases which were considered entirely inoperable and therefore were not submitted to any surgical treatment. It is self-evident on the other hand, that the differences in the conceptions of the operability of the cases influence to a great extent the postoperative results. Nevertheless a fairly accurate idea of the results may be formed from an analysis of the recent publications. In the years 1907-1908 there appeared a number of publications with reports of a decade of work with Halsted's and similar methods of radical operations for carcinoma of the breast. Chart I, taken from Halsted's<sup>1</sup> publication, may serve as an example of the results obtained.

CHART I

	Cases	Cured	Per cent.	Cured 3 years	Per cent.
Axilla and neck negative .....	60	45	75	51	85
Axilla negative, neck negative....	110	27	24.5	34	31
Axilla and neck positive.....	40	3	7.5	4	10
Total .....	210				

\* Read at the meeting of the Section on Surgery of the New York Academy of Medicine, November 3, 1916.

## SURGERY IN EMPYEMA OF THORAX

As a means to the end of lowering the mortality, it is mete at this juncture to petition the internists to adopt a like attitude for empyema as they at present assume in appendicitis, calling upon the surgeon the moment the existence of empyema is entertained, so that while the diagnosis is *sub judice* and in the making, they may jointly pass upon radiosopic findings and radiograms upon which confirmatory puncture as the initial step of any operation is predicated.

The decapsulation of the lungs along a distinct line of cleavage; the return of lung expansibility; hemorrhage and drainage, all constitute features analogous to the steps in the performance of prostatectomy; only the loss of blood being vastly larger in the latter.

In closing we wish here to cite a very recent confirmation of our attitude: In a discussion at the Société de Chirurgie de Paris,<sup>6</sup> in the early part of this year (1916), on "Extraction of Bullets" lodged in the lung, Duval<sup>6</sup> took issue in saying that surgeons up to the present time were too timid in regard to surgery of the lung and pleura. The lung may be operated on without special instruments or apparatus according to the ordinary principles of surgery. Total pneumothorax, partial exposure of the pulmonary lobes, freeing them from adhesion on all sides, exposure and delivery of the lobes in order to reach the mediastinum or diaphragm, are simple procedures without particular danger. The lung is a tolerant organ which may be operated on as easily as an intra-abdominal viscus and with the aid of an excellent rib retractor whereby all the view of the interior of the thorax that is necessary is obtained.

For the many courtesies to assist and privileges to independently operate numerous patients, as well as encouragement and advice in the preparation of this paper, my thankful acknowledgments are due to Dr. Lilienthal.

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- <sup>2</sup> Kuttner, H.: Operationen am Brustkorb., Chir. Operationslehre. Bier, Bd. II, p. 148.
- <sup>3</sup> Perthes: Lehrb. d. Chir. Wulstein & Wilms, vol. i, p. 533.
- <sup>4</sup> Lilienthal and Ware: Recent Progress in The Treatment of Empyema. Med. Record, July 15, 1916.
- <sup>5</sup> Wilensky: Empyema of the Thorax. Surg., Gyn., and Obst., May 15, 1915, p. 501.
- <sup>6</sup> Paris Letter, J. A. M. A., vol. lxvi, p. 1037.

The limitations of the surgical treatment of carcinoma of the breast are due to the following reasons: R. R. Greenough, C. C. Simmons and J. D. Barney<sup>3</sup> have shown that 52 per cent. of the cases in which the operation fails do not show any local recurrence in the operative field, but only metastases in distant regions. In these cases the removal of the local growth was complete, and the metastases were either formed before the operation, or else a tumor embolus was carried away from the primary tumor in the course of the operation. In either event the extent of the operation could not influence the final result. Thus it is self-evident that in the advanced cases which represent three-quarters of all cases submitted to the operation, the probability of the existence of a metastasis before the operation, and of a consequent failure of even an ideal operative method, is great.

Handley<sup>4</sup> attempts to prove that embolism has no significance in the formation of metastasis of carcinoma of the breast. According to his conception, metastasis is formed by a process of "lymphatic permeation." The tumor cells grow along the lymphatic vessels until they reach the nearest lymph-glands, and from these glands the cells enter the next lymphatic vessel. This process is continuous, and the appearance of an apparently isolated tumor nodule is due to the fact that a perilymphatic fibrosis destroys the permeated lymphatic vessels which form the lines of communication. The formation of metastases in distant organs Handley ascribes to the proliferation of cancer cells which escape from the subserous lymphatic plexuses into the serous cavities, pleura, or peritoneum. The cells are then distributed through these cavities under the influence of gravity and of visceral movements and implanted on the serous surface of the viscera. As a proof of this contention he cites the fact that parts of the skeleton distal to the elbow and knee-joints usually escape cancerous invasion. Now, in the first place Case VII shows skeletal metastases distal to the elbow (Fig. 9). Moreover, it is impossible to conceive even on the basis of Handley's theory how a distant metastasis without a local recurrence after an operation occurs, unless the transport of the cancer took place before or during the operation.

CHART III

Years after operation patients are alive	Number of cases	Per cent.
4	123	43.20
8	48	16.9
10	35	12.32
15	23	8.1
20	7	2.46
	292	

## SKELETAL METASTASES IN CARCINOMA OF THE BREAST

Halsted reports in all on 293 cases. Eighteen cases could not be traced and 65 cases had only palliative operations. The remaining 210 cases are divided into 3 groups. The first group consists of early cases in which there is no involvement of the lymphatic glands. In the second group, there are placed the advanced cases with the involvement of the axillary glands, and in the third group the far advanced cases with the involvement of both the axillary and neck glands.

Of the 60 cases of the first group, 51 cases, or 85 per cent., remained well three years after the operation. It is remarkable to note in this connection that even the cases of the Johns Hopkins Hospital, notwithstanding the active educational propaganda carried out by Bloodgood, only 20 per cent. of all the cases reported were in the first group, or in the early stages of the disease. It is probable that were the cases in which even a palliative operation was refused added to the report, then the percentage of the early cases would have been even smaller.

CHART II

Group	Series	Number of cases operated	Number of cases cured	Per cent.
I	I	14	11	78.5
	II	7	6	84.7
II	I	68	20	29.4
	II	25	8	32
III	I	7	0	0
		5	0	0

Chart II presents a very interesting analysis of 200 cases operated upon by Steinthal.<sup>2</sup> He divided 126 cases which were followed up in 3 groups, similar to those described by Halsted. Each group is again divided into 2 series. The first series of cases were operated by the old methods, and the second series by the modern radical methods. The analysis of his material shows that while in the first group, or the early cases, the radical operation produced better results than the old operations, the difference in the results in the advanced cases is not so marked. In the third group no advantage was obtained from the radical operation, either by Steinthal or Halsted, though the latter reports that 10 per cent. were cured, while all the cases of Steinthal in this group died, notwithstanding the operation. Thus the more advanced the disease, the smaller is the probability of obtaining permanent results, even from the most radical surgical treatment. In his latest publication Steinthal expresses the opinion that the increase in the percentage of cured cases is not due to the improvement in the operative technic, but to the earlier recognition of the disease.

tinue for a long time without causing any symptoms, and when at an autopsy metastases are found, both in the bones and in many other organs, it is highly probable that the latter appeared subsequently to the formation of the skeletal metastases. The fact that E. Kaufman<sup>7</sup> found skeletal metastases in the bones in 52.3 per cent. of the cases that died of carcinoma of the breast is a true indication of the frequency of the condition.

#### PRE-OPERATIVE DIAGNOSIS OF SKELETAL METASTASES

A radical operation for carcinoma implies an attempt at complete eradication of all cancer tissue within the organism. While a radical amputation of the breast is not accompanied by a high postoperative mortality, it is nevertheless a severe operative procedure. It is usually followed by a prolonged after-treatment, and frequently by disability, pain and swelling of the arm. Moreover, the thorough clearing out of the axilla may be followed by a dissemination of cancer tissue into distant organs and subsequent formation of metastases. In view of all this, it is imperative to ascertain before the operation whether there are any metastases present in any distant region of the organism, of the patient.

Metastases in the lungs and in the liver as a rule produce clinical symptoms and are easy to recognize. Skeletal metastases, on the other hand, as stated above, may continue for a long time without causing any symptoms whatever. The frequent reports of pathological fracture occurring in patients who apparently enjoyed previously perfect health, and in whom only the accident revealed the presence of carcinoma, bear out this assertion.

The mechanism of the development and growth of skeletal metastases, as will be shown later, shows the reason for the late development of the clinical symptoms, but in any event, it is certain that a case of carcinoma of the breast with the involvement even only of the axillary glands may harbor metastases in the bones which do not manifest themselves in any way. The only method by the aid of which many of such metastases may be detected is the röntgenographic examination of the skeleton.

The röntgenogram usually reveals a central focus of bone destruction which is evidently replaced by carcinoma tissue. It must be admitted that a negative finding is not conclusive, since the tumor nodule in the bone may be too small and has not destroyed as yet a sufficient amount of the bone tissue to present a shadow on the plate, but a positive result makes the diagnosis of the condition certain. In

## SKELETAL METASTASES IN CARCINOMA OF THE BREAST

Similar conclusions must be drawn from the analysis of Chart III obtained from the report of a French surgeon, Heurtaux.<sup>5</sup> He operated during the 30 years previous to the date of his report on 341 cases. The operation consisted in the removal of the breast and the axillary lymphatic glands without the disturbance of the pectoral muscles. Though his operation is not as thoroughly radical as Halsted's, 43.3 per cent. of the 284 cases which could be traced remained well 4 years after the operation. This remarkable result may be partly due to a special selection of cases for the operation, but what makes the investigation of Heurtaux of the greatest value is the fact that he watched and controlled his patients for 30 years. He was thus enabled to estimate the ultimate results at long intervals after the operation, and as Chart III shows twenty years after the operation only 2.46 per cent. of the cases remained alive and free from the disease. While there are many reports in the literature of isolated cases of late recurrence of carcinoma of the breast, Heurtaux is the only investigator who showed the remarkable frequency with which these late recurrences take place.

Thus the analysis of the cases of Steinthal and Heurtaux demonstrate clearly two facts in relation to the true value of the radical amputation of the breast for carcinoma. In the first place in advanced cases, the result of the radical operation is not better than the results of simpler surgical procedures, furthermore in the greater part of the cases which are apparently cured 3, 4 and 5 years after the operation, the disease recurs at a later date. This latter phenomenon is due in over half of the cases, not to a local recurrence of the disease, but to metastases in distant regions.

Now, carcinoma of the breast metastasizes most frequently in the lungs, bones and the liver. The involvement of the latter organ is probably due in accordance with the theory of Handley to a lymphatic permeation, *i.e.*, a local outgrowth from a neighboring region. Metastasis in the liver occurs usually late in the course of the disease and is secondary to an extensive local recurrence and metastases in the lungs or bones. The formation of metastases in the latter organs is undoubtedly due, as the writer stated in several publications,<sup>6</sup> to an embolic transport of cancer tissue before or during an operation and may take place without a local recurrence. The development and the course of metastases in the lungs is usually quite rapid and is accompanied by early clinical symptoms indicative of the condition. The metastases in the bone are apparently the most frequent cause of the late recurrence in carcinoma of the breast. The condition may con-



eighth, ninth and tenth ribs. A microscopic study was done of the ribs and trochanters.

CASE IV.—Mrs. T. S., aged thirty-nine, admitted to the hospital May 14, 1914, with a recurrence of a carcinoma of the right breast which was amputated about six months previously. Clinical and röntgenographic examinations revealed metastases in the right femur. Patient died June 17, 1915. Autopsy showed medullary carcinoma of the breast, metastases in the axillary, cervical, mediastinal, bronchial and retroperitoneal lymph-glands and in the head of the right femur. The metastasis in the femur served for pathological study.

CASE V.—Miss R. S., aged forty-two. A radical amputation of the right breast was done in August, 1915, for carcinoma with involvement of axillary and supraclavicular lymph-glands. Four months later there developed a kyphosis, a swelling at the regions of both trochanters and inability to walk; two months later the patient began to complain of severe headaches, became delirious, then developed a right hemiplegia which was followed by death two days later. No autopsy could be obtained, but there was undoubted clinical evidence of metastasis in the spine.

CASE VI.—Mrs. R. E., aged fifty-six. A radical amputation of the left breast for carcinoma was done in the Brooklyn Jewish Hospital in August, 1913. Three weeks after the operation there set a pain in the right thigh, later the left thigh became involved. The patient was admitted to the Montefiore Home and Hospital on November 10, 1914. One month after admission she sustained a fracture of the right femur. The patient died on January 1, 1916. Autopsy showed metastases in the liver, ribs and both femurs. This case showed a very slow progress of the skeletal metastases; pain in the thighs developed three weeks after the operation, consequently the metastases were already present during the operation, since the cancer nodule in the bone must obtain a certain size before the pains appear and still the patient lived two and a half years after the operation.

The analysis of the röntgenograms gives very interesting indications of the pathological development of the process, the plates taken immediately after the fracture occurred show the fracture in the right femur (Fig. 1) and destruction of bone, *i.e.*, tumor masses further down the shaft (Fig. 2), and reveal nothing abnormal in the left femur (Fig. 3); röntgenograms taken ten months later show in the right femur (Fig. 4) bridges of newly-formed bone in the area of the old fracture. Indeed the latter appears to be firmly healed, a fact which was noted clinically. Below the old fracture there has taken place a new fracture. The left femur (Fig. 5) shows now distinct areas of metastases. It is

## SKELETAL METASTASES IN CARCINOMA OF THE BREAST

view of the importance of the subject it is remarkable how little attention is being paid to this method of diagnosis of skeletal metastasis.

As stated above metastases, usually in the bones, may be present at the time of the operation in 52 per cent. of the advanced cases of carcinoma of the breast, even with involvement only of the axillary glands. It is therefore imperative that in every advanced case, or better still, in every case of carcinoma of the breast, a röntgenographic examination be made of the skeleton before the operation. If it is too expensive or difficult to explore the whole skeleton, then those parts should be examined in which metastases most frequently occur, namely the spine and the femurs.

### REPORT OF CASES

At the service of the writer in the Montefiore Hospital, the röntgenographic examination of the skeleton of all cases of carcinoma of the breast is a routine procedure. During the past three years the writer observed 10 cases of carcinoma of the breast complicated by skeletal metastases. The clinical, röntgenographic and pathological study of these cases presented several points of interest in connection with the questions of prognosis and therapy of carcinoma of the breast. The following is a brief résumé of the clinical histories of the cases:

CASE I.—Mrs. B., aged thirty-nine, an advanced carcinoma of the right breast with involvement of the axillary and the supra-clavicular glands. A radical amputation of the breast was done on November 17, 1913. Pain in the hip-joints developed two months after the operation; six months after the operation the patient became bedridden, developed perfect clinical evidence of metastases in both femurs, and died nine months after the operation. No autopsy could be obtained.

CASE II.—Mrs. G., aged forty-three, was admitted to the Montefiore Hospital on December 3, 1913. Two years previous to the admission to the hospital the patient underwent a radical amputation of the right breast for carcinoma. The patient died on December 31, 1913. Autopsy showed metastases of carcinoma in the viscera and in the sternum. The latter served for pathological study.

CASE III.—Mrs. B. H., aged forty-one, admitted to the Montefiore Hospital on January 21, 1914, with an inoperable carcinoma of the right breast, painful spine and inability to walk. Clinical and Röntgen examination showed metastases in the eighth, ninth and tenth ribs, and in both femurs; the patient died on May 20, 1914. Autopsy showed carcinoma of the breast and metastases in the axillary lymph-glands, pleura, both trochanters and the

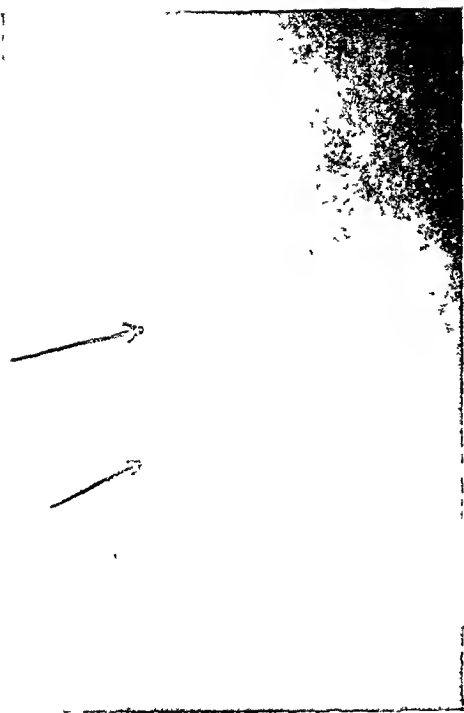


FIG. 5.—Case VI. Röntgenogram of the neck of the left femur, taken ten months later. The arrows show the light spots of bone absorption—metastases.

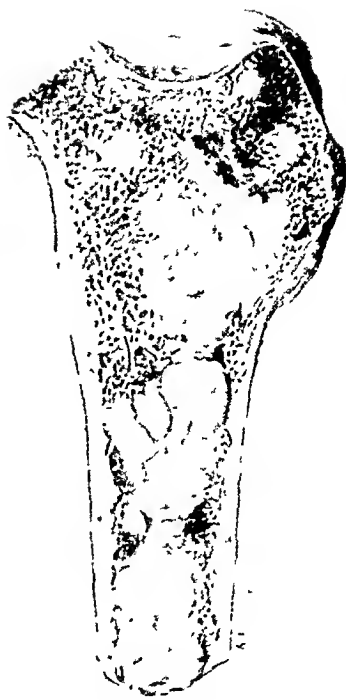


FIG. 6.—Case VI. Sawed open surface of the left femur. Shows metastases and hemorrhages.



FIG. 7.—Case VII. Röntgenogram of femur and pelvic bones. Shows irregular bone destruction.



FIG. 1.—Case VI. Röntgenogram of the neck of the right femur. The arrows show the line of fracture.



FIG. 2.—Case VI. Röntgenogram of the shaft of the right femur. The arrows show the metastatic tumors.

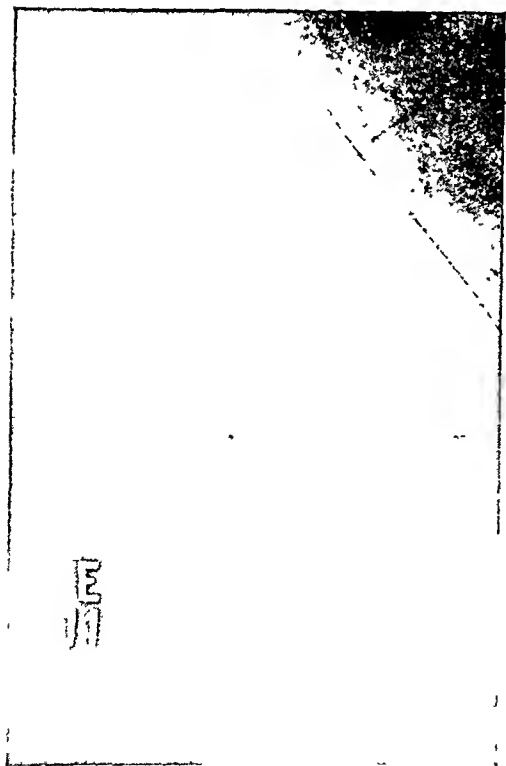


FIG. 3.—Case VI. Röntgenogram of the neck of the left femur. It shows no abnormality.



FIG. 4.—Case VI. Röntgenogram of the neck of the right femur, taken ten months later. Shows double fracture.



FIG. 10.—Case VII. Röntgenogram of skull. The arrow shows bone absorption.



FIG. 11.—Case VIII. Röntgenogram of spine. Shows absorption of bone of the eleventh and twelfth dorsal vertebrae.



FIG. 12.—Case VIII. Röntgenogram of the neck of femur. The arrow shows bone absorption in the upper portion of the neck.

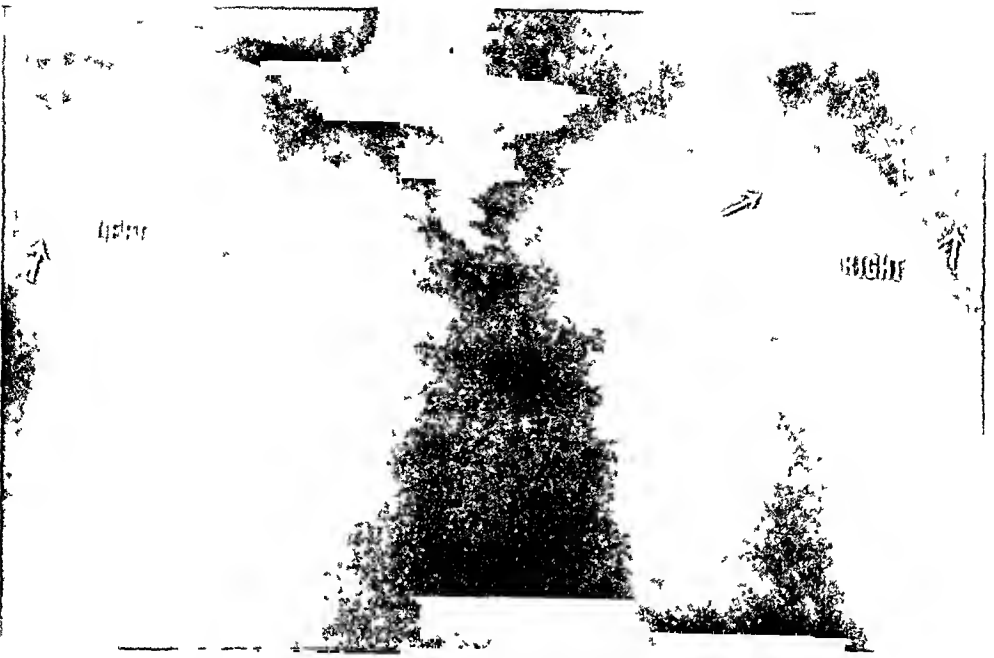


FIG. 8.—Case VII. Rontgenogram of chest Shows absorption of bone.



FIG. 9 —Case VII. Rontgenogram of humerus, radius and ulna. Shows extensive irregular bone destruction.



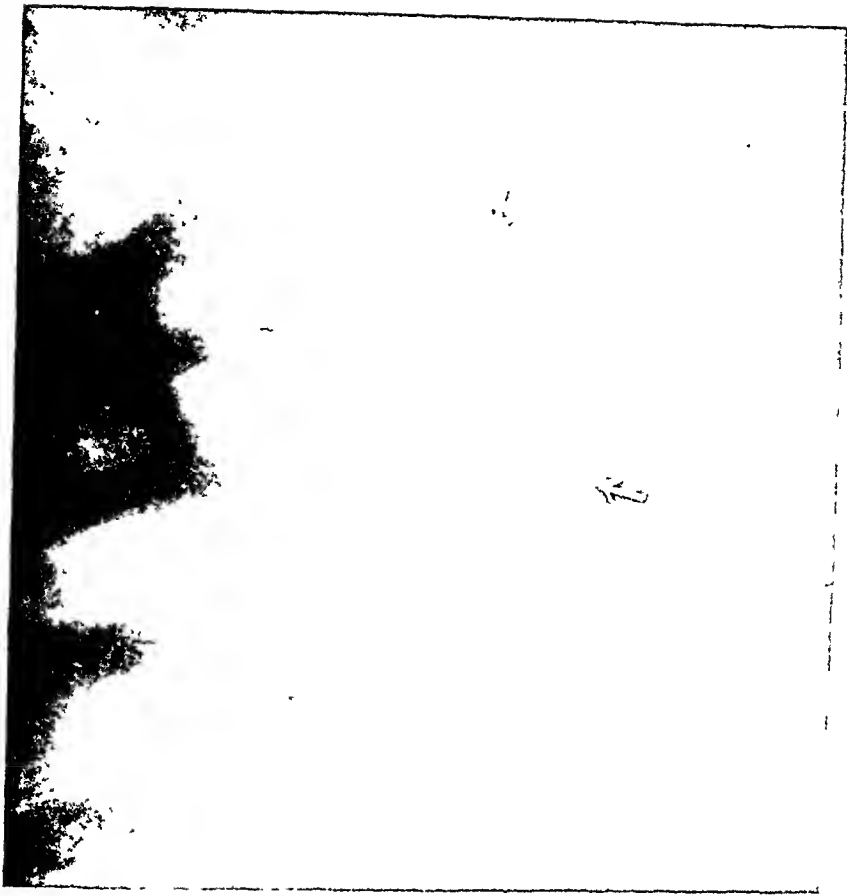


FIG. 13.—Case IX. Röntgenogram of the left half of the chest. Shows destruction of bone in the left clavicle.



FIG. 14.—Case X. Röntgenogram of the spine. Shows bone destruction in the centre and new bone formation in the periphery (two bridges) in the contiguous portions of the second and third lumbar vertebræ.

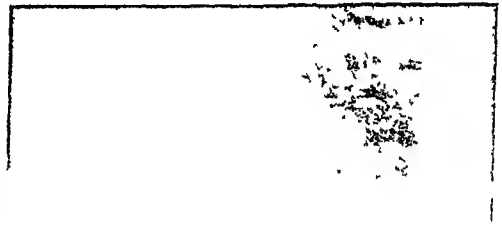


FIG. 15.—Case X. Röntgenogram of the spine taken one year later. Shows some increase in the new bone formation.



January 22, 1916: Patient was unconscious for the last two days; the patient died on January 22, 1916. An autopsy could not be obtained, but the clinical history, which was given here at greater detail than in the other cases, as well as the röntgenograms prove conclusively the presence of an extensive skeletal carcinoma. The case presents the most extensive involvement of the skeleton of any described in the literature and shows that skeletal metastases may develop below the elbow. This last fact is important since, as stated above, Handley bases his pathological conception and operative technic to a great extent on the fact that skeletal metastasis in carcinoma of the breast does not develop below the elbow or knee-joint.

CASE VIII.—Mrs. R. R., aged forty-three, admitted to the Montefiore Home and Hospital January 16, 1916. Present illness began May, 1915, when the patient noticed a very small lump, the size of an orange seed, underneath the skin of the left breast. In August the breast was amputated at Beth Israel Hospital. In October the patient began to complain of pain in lower extremities and back.

A röntgenogram taken on January 20, 1916, showed great absorption of bone of the eleventh and twelfth dorsal vertebræ (Fig. 11). The entire lumbar spine had a worm-eaten appearance: the upper portion of the neck of the right femur (Fig. 12) shows multiple areas of bone absorption. Patient died on February 13, 1916. The autopsy performed by Dr. B. S. Kline showed carcinoma of breast with recurrence in wound following removal. Metastases to the regional lymph-glands, liver, pancreas, lung, right femur and in the eleventh and twelfth dorsal vertebræ. The metastases in the bones were studied microscopically.

CASE IX.—Mrs. B., aged fifty-four. The patient underwent a radical amputation of the left breast for carcinoma in 1911. In the summer of 1914 there developed a swelling measuring 2 inches long,  $\frac{3}{4}$  inch wide, and 1 inch high, adherent to the left clavicle. The röntgenogram (Fig. 13) shows partial destruction of the bone and consequently a metastasis in the left clavicle. The case was referred to the writer (by Dr. Bodenheimer) in August, 1914. Under a combined radium and Röntgen treatment the swelling disappeared. The case was reported in September, 1915.<sup>8</sup> Now nearly two and a half years after beginning of the treatment, the patient is clinically well and does not show any recurrence of carcinoma anywhere.

CASE X.—Mrs. D. L., aged forty. The patient had a radical operation of the right breast for carcinoma done in May, 1915. On leaving the hospital the patient felt perfectly well for two

## SKELETAL METASTASES IN CARCINOMA OF THE BREAST

very striking that the sawed open surface of the left femur (Fig. 6) shows the metastases practically in the same positions as on the röntgenogram.

CASE VII.—Mrs. A. B., aged forty-five, previous illness began a year ago with pain in the left hand, radiating down from the shoulder. She consulted a physician who called her attention to little lumps in the left breast: she went to Mt. Sinai Hospital where her left breast was amputated; after leaving the hospital the patient experienced great pains in various regions of the body, chest, legs, back, etc. The pain grew gradually worse, until six months later she went to Gouverneur Hospital, where she stayed fourteen days. The patient became gradually weaker, paler, and complained of headaches, pains in various regions of body, loss of weight and impairment of vision. On October 1, 1915, she was admitted to the Montefiore Home and Hospital. On admission röntgenograms of nearly the whole skeleton of the patient were taken with the following results:

Hips: Marked irregular bone destruction of the upper part of both femurs and the pelvic bones (Fig. 7).

Shoulders: Advanced irregular bone absorption of all the bones entering into the formation of the shoulder-joints.

Ribs: The posterior parts of almost all the ribs, especially on the left side, show a great number of spots of bone destruction. Fig. 8 shows the condition of both shoulders and the ribs and Fig. 9 the same in radius and ulna.

Skull: All the bones of the skull show a great amount of irregular bone destruction of both tabulæ (Fig. 10).

All the abnormalities in the skeleton stated above were due to multiple metastases of carcinoma in the bones.

December 30, 1915: The palpation of the skull shows a protuberance over the left temporal region, consisting of a soft diffuse mass, about 2 inches in diameter (a massive bone metastasis).

Palpation of the left side of the chest wall is painful. Second, third and fourth ribs feel rough and nodular. The left knee-joint is swollen and painful; an enlargement is apparent at the head of the tibia.

January 13, 1916: A swelling has developed in the middle of the right clavicle, which is soft on palpation, and indicates a complete destruction of the bone in this section of the metastatic area.

January 19, 1916: Patient's speech is not clear, slow and confused; complains more of pain than heretofore, and in addition to the already found swellings, she developed a swelling over the right Poupart's ligament which is soft, doughy and easily compressible, but not tender.

the latter instances as stated above no morphological abnormality could be found in the bone-marrow.

As the tumor nodule increases in size it approaches and invades the compact osseous tissue or the compact osseous partitions of the cancellated bone, and then there begin to appear the characteristic changes in the bone tissue. It is generally accepted that there are two classes of skeletal metastases of carcinoma: *osteoplastic*, in which there takes place a great deal of new bone formation around the metastatic tumor, and *osteomalacic*, in which the change of the normal tissue surrounding the metastasis consists in extensive destruction of the compact bone. These two distinct conditions can be easily differentiated on the gross inspection of skeletal metastases. However, the microscopic study of the cases of the present investigation by the writer has shown that both conditions are usually present side by side, and only in one case *osteosclerosis*, or new bone formation, predominates, while in another *osteoporosis*, or the destruction of the old bone, is mainly evident. Figs. 18 and 19 show an extensive new bone formation, while Fig. 19 presents only destruction of the old bone, and both specimens were obtained from different regions of the same metastatic tumor.

The mechanism of the bone destruction in metastases of carcinoma differs from the one observed in inflammatory osteoporosis. Von Recklinghausen<sup>9</sup> first made the observation that the large polynuclear osteoclasts which destroy the bone in osteoporosis are very seldom found in the lacunæ of the bone surrounding a growing metastasis of carcinoma. This fact was confirmed by most of the subsequent investigators. In view of the absence of the large osteoclasts, Von Recklinghausen presumed that there takes place in the bone a softening by the removal of the inorganic salts, and a subsequent absorption without the aid of any cells, a condition similar to the one found in osteomalacia. Apolant,<sup>10</sup> Erbslöh,<sup>11</sup> Askanazy,<sup>12</sup> are also of the opinion that osteoporosis in skeletal carcinoma may take place without the aid of special cells. On the other hand, Wolff<sup>13</sup> and Goetsch<sup>14</sup> believe the cancer cells act as osteoclasts and destroy the compact bone, and Axhausen<sup>15</sup> maintains that the small elongated mononuclear connective-tissue cells, frequently found close to the walls of the lacunæ, are special osteoclasts derived from the cancer stroma. In the specimens studied by the writer both carcinoma cells, as well as the small connective-tissue stroma cells, are found in close immediate apposition to the walls of the lacunæ. The carcinoma cells were so frequently the only cellular elements within the lacunæ of the bone that there

## SKELETAL METASTASES IN CARCINOMA OF THE BREAST

weeks, when she began to experience pain for the first time. This pain was situated in the region of the lower lumbar vertebræ, the patient claiming that the pain was similar to that felt during child-birth. The above has persisted ever since. With the onset of pain there developed loss of weight and general weakness. The pain was very severe and the patient has been confined to bed. The patient was admitted to the Montefiore Home and Hospital on November 10, 1915. A röntgenogram of the spine taken on admission (Fig. 14) showed a slight destruction of the contiguous portions of the second and third lumbar vertebræ with some bone condensation and very marked new bone formation in form of bridge formation on both sides.

The patient received Röntgen treatment both over the chest and the region of the second and third lumbar vertebræ. At present, one year after admission, the patient left the hospital greatly improved, able to walk around and work. A later röntgenogram (Fig. 15) shows apparently some increase in the bone formation in the region of the second and third vertebræ.

### CLINICAL AND PATHOLOGICAL CONSIDERATIONS

The clinical and röntgenologic study of the cases shows that the skeletal metastases undoubtedly were present in all of them at the time of the operation. Pain in the different parts of the skeleton either appeared before or very soon after the operation. The röntgenograms taken upon the admission to the hospital showed usually an extensive involvement of the bone, and the identical condition was found at the autopsy. All this shows that the metastases were of long standing. Statistical investigations as stated above indicate that skeletal metastases of carcinoma may be very slow in their development. It may take years before clinical manifestations of any kind present themselves. The pathological studies of the writer bear out and elucidate the reasons for this phenomenon.

The metastasis of carcinoma in the bone begins its development within the marrow, and when the group of cancer cells are small, the surrounding bone-marrow appears quite normal. Figs. 16 and 17 present microphotographs of two such small cancer nodules within a bone-marrow space. Von Recklinghausen claims that the development of the metastasis is preceded by a hyperæmia and hæmostasis due to the obstruction of the capillaries by endovascular tumor emboli. In the specimens studied by the writer hemorrhages and hyperæmia were noted frequently around large tumor masses, in the femur, for instance (Fig. 6), but not around minute metastatic nodules. In

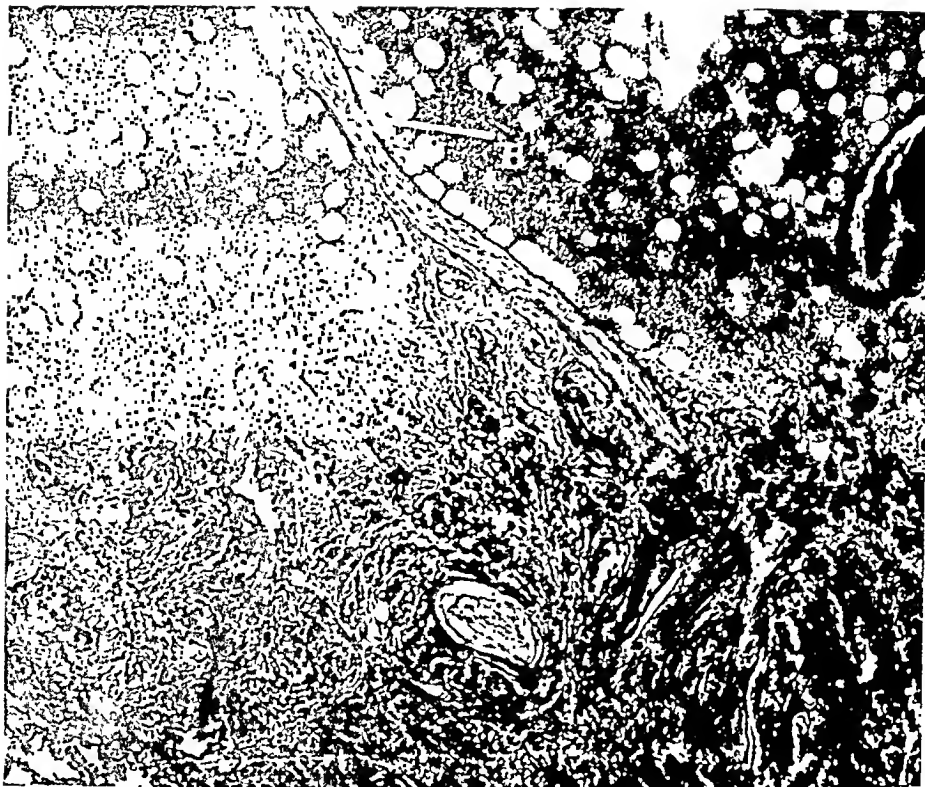


FIG. 18.—Microphotograph shows a great deal of new bone formation in the vicinity of an old bridge of compact bone tissue. *B* shows old bone; *A*, new bone.

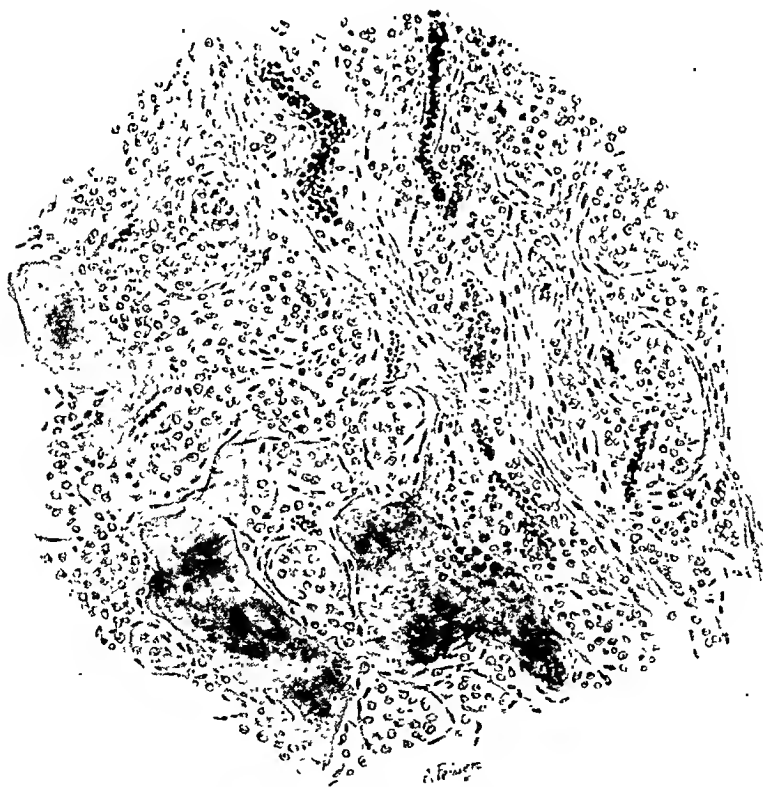


FIG. 19.—From a microscopic section of a skeletal metastasis stained with Van Gieson. Shows collagen fibrils emerging from the old bone and uniting with other fibrils.

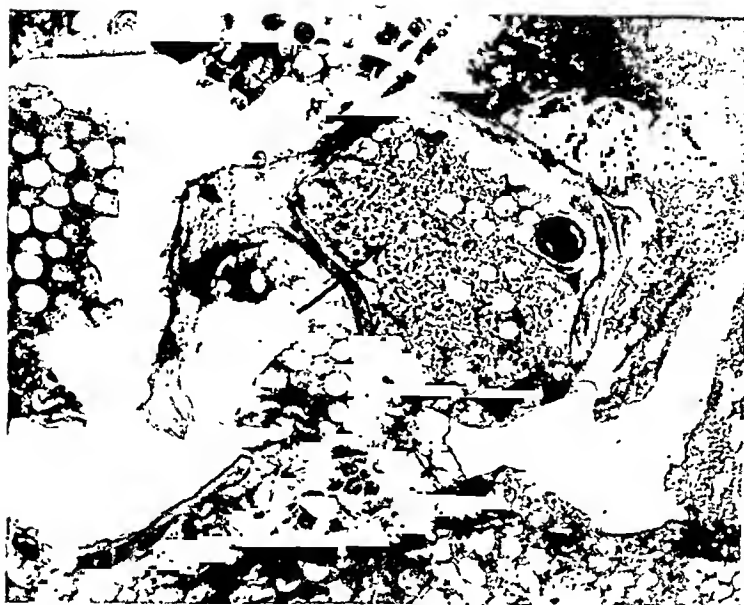


FIG. 16.—Microphotograph of a bone-marrow space. The arrow shows a small island of cancer cells. (Low magnification.)

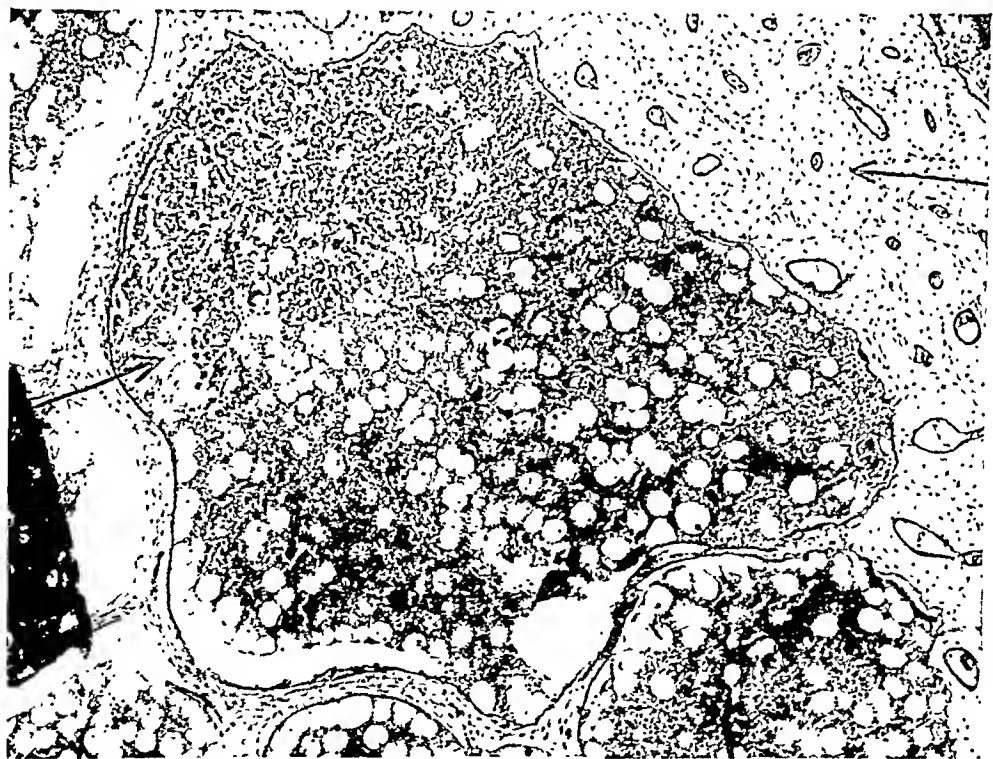


FIG. 17.—Microphotograph of a bone-marrow space with a small nodule of carcinoma (larger than in Fig. 16). The arrow *a* shows the carcinoma. The arrow *b* shows compact bone. (Low magnification.)



FIG. 22.—Röntgenogram of case of sarcoma of mandible taken after treatment. The arrows show the new bone formation.

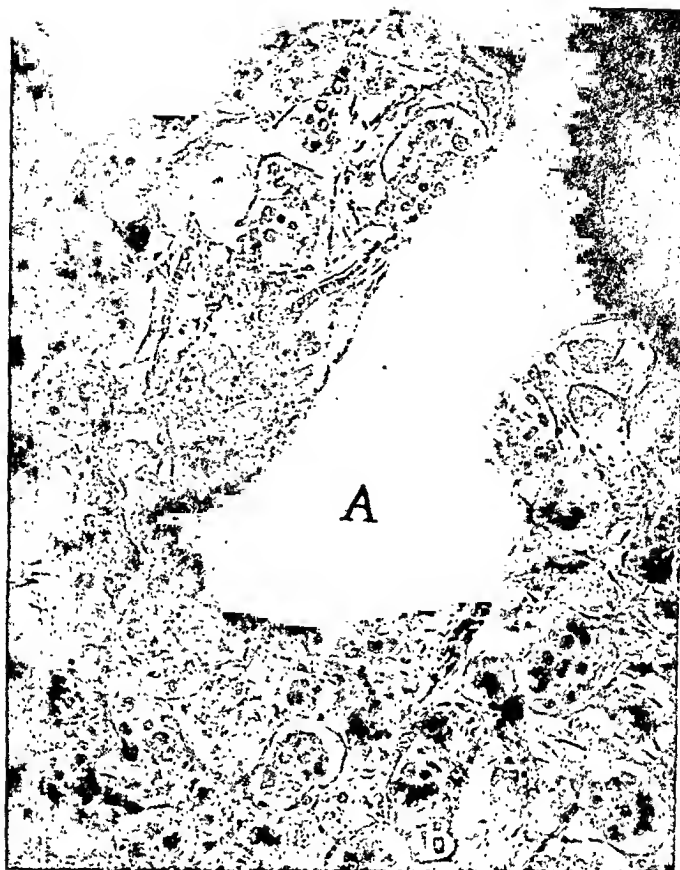


FIG. 20.—Microphotograph, two bone lacunæ filled with carcinoma cells. A, shows bone; B, carcinoma. (Low magnification.)



FIG. 21.—Röntgenogram, of case of sarcoma of mandible taken before treatment. Shows tumor with two radium tubes *in situ*.



subsequently became firm and seemed clinically healed (Fig. 4), while later a second fracture took place below the first. Here apparently nature succeeded in healing one metastatic focus in the bone, while in another place the tumor grew unchecked. Such temporary healing of a pathological fracture within a skeletal metastasis was described in several instances.

Thus the microscopic study of skeletal metastasis gives a clear evidence of the interaction which always takes place between the normal organ tissue and the cancer cells in the beginning of the development of a metastatic tumor from a transported cancer embolus. Upon the result of such an interaction depends the success or failure of the formation of metastasis. In the bone the conditions are evidently more favorable for at least temporary suppression of the proliferation of the cancer cells by the newly-forming bone tissue, and therefore skeletal metastases develop only slowly and appear late.

#### THE PROGNOSTIC SIGNIFICANCE OF SKELETAL METASTASES

The radical operation for a malignant tumor means a complete eradication of all tumor tissue from the organism. It is patent that a radical operation in this sense of the word is impossible as long as a skeletal metastasis was diagnosed before the operation. Furthermore, Heurtaux has shown that ten years after a breast amputation only 12.32 per cent. remain free of the disease and twenty years after the operation only 2.46 per cent. remain free. It would then seem that in the overwhelming majority of all the cases of carcinoma of the breast the best surgical methods of treatment do not completely eradicate the disease, but only prolong life. But on the basis of the latter interpretation of the therapeutic results in carcinoma of the breast skeletal metastases give a better prognosis than metastasis in other organs, since they are much slower in their development and may therefore be more readily controlled.

#### RADIUM AND RÖNTGENOTHERAPY OF SKELETAL METASTASES

As stated above, the radical amputation of the breast in the presence of skeletal metastases cannot cure completely the disease. On the other hand, the operation if correctly performed may prolong the life of the patient, since the removal of the primary tumor diminishes the possibility of subsequent formation of metastases in other organs than the bone. But the operation, while aiming at a complete as possible removal of the main mass of the tumor, does not need to be entirely radical. It is more important not to handle and massage the tumor too energetically during the operation and thereby transport cancer cells

## SKELETAL METASTASES IN CARCINOMA OF THE BREAST

cannot be any doubt that carcinoma cells act as direct osteoclasts. Fig. 20 shows lacunæ filled with carcinoma cells. The impression gained by the writer is that the small stroma cells only subsequently enter between the bone and the carcinoma cells. But even if the possibility be admitted that occasionally the stroma cells may act as osteoclasts, it seems quite apparent that the tumor itself, by the aid of its formed elements, first destroys the bone and then grows by occupying the produced space.

While the mechanism of osteoporosis in skeletal metastasis as stated above is at least similar to the mechanism of the destruction of any normal tissue surrounding a growing malignant tumor, the osteosclerosis, or the extensive formation of new bone tissue, is characteristic of skeletal metastases.

Von Recklinghausen claims that this extensive new bone formation is due to the hyperæmia described by him and mentioned above. Courvoisier<sup>10</sup> and Kaufman<sup>7</sup> maintain that a metastasis in the bone is always surrounded by a zone of inflammation, and this latter caused the osteosclerosis. Askanazy<sup>12</sup> thinks that the metastasis at first produces an osteoporosis, which is followed by a bone necrosis, and the necrotic bone acting as a foreign body caused a new bone formation. Wolf,<sup>13</sup> Courvoisier,<sup>10</sup> and Kaufman,<sup>7</sup> are of the opinion that carcinoma cells may act as osteoclasts and form new bone tissue. Fig. 19 presents a picture very frequently observed by the writer. It shows collagen fibrils developing in abundance from the old bone. These fibrils gradually unite in thick bundles and subsequently form new bone tissue. The latter is clearly formed from the constituent parts of the old bone tissue. On the other hand, as stated above, the writer did not observe any hyperæmia, inflammation or any other abnormality of the bone-marrow at the beginning of the development of the metastases. Neither did the writer find any necrosis of the bone in any of the specimens examined. It must be concluded in agreement with Axhausen's<sup>15</sup> conception that some unknown chemical irritant emanating from the carcinoma cells acts on the old bone tissue and stimulates its proliferation.

Thus there constantly and side by side take place in skeletal metastasis two processes. On one hand the tumor cells destroy the normal bone tissue and occupy its place, and on the other hand the remaining bone tissue proliferates and creates new bone. The latter is quite probably an attempt at self-defense on the part of the organism. The newly-formed bone tissue may compress and destroy the cancer cells, or at least inhibit their proliferation. Case VI shows such a condition. There took place a pathological fracture in the right femur, which

Case X is now clinically well one year after admission to the hospital, while a year ago it presented the picture of a most hopeless condition, ever met even among cases of inoperable carcinoma. Though it cannot be stated as yet for how long the patient's life will be prolonged, the achievement in this case is certainly sufficient to encourage further attempts at the same method of treatment.

It would lead too far to go here into details of the technic of radiotherapy, but one point must be considered, the treatment must be continued at stated intervals for a long time, and if it is interrupted too soon, the metastatic tumor may become active again, destroy a large area of bone and then the subsequent radiations will be of no avail.

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## SKELETAL METASTASES IN CARCINOMA OF THE BREAST

into the circulation, than to remove every vestige of it. The writer<sup>8</sup> has shown in a previous publication that small islands of tumor cells can be destroyed by radium and Röntgen rays, even at a great distance from the skin, and it should therefore be easy to eradicate by the aid of the radiations small remnants of the tumor located in the axilla, or over the chest wall. The diathermic coagulation of tissue which the writer<sup>17</sup> discussed in previous publications, and which destroys the carcinoma cells *in situ* without opening the blood and lymph channels, may become the operative methods of choice for such incomplete operations when the correct technic is developed.

Thus the correct treatment of carcinoma of the breast, complicated with skeletal metastases, consists in the operative removal of the gross tumor mass, combined with radium and Röntgen therapy. The radiations in a postoperative case of carcinoma of the breast should not be given only over the operative field and over the chest wall, which is the procedure generally adopted to-day, but should include, if not the whole skeleton, at least the spine and the heads of both femurs. Moreover, this combination of surgery and radiotherapy should be the method of choice in all advanced cases of carcinoma of the breast, even when there is as yet no evidence of skeletal metastases.

The writer has shown<sup>18</sup> that one of the important effects of radium and röntgenotherapy consists in the formation of an extensive connective-tissue stroma, surrounding and compressing the tumor cells. In skeletal metastases this stroma, as the pathological study reported above shows, is transformed into bone. It is thus self-evident *a priori* that the radiotherapy must enhance the results of the attempts at cure produced by nature.

In a case reported by the writer in 1915, though not a metastatic carcinoma, but a primary sarcoma of the bone (right mandible), new bone formed under the influence of radium and Röntgen therapy. Eight weeks after the beginning of the treatment, the tumor had completely disappeared, and instead there was present a large cavity lined by a shell of bone. Fig. 20 shows a röntgenogram taken immediately at the beginning of the treatment, with the radium tubes *in situ*. There is seen a nearly complete loss of bone around the tumor. Fig. 21, a röntgenogram taken after treatment, shows that the swelling is surrounded by a great deal of new-bone formation. The Cases IX and X of the present report clearly show that radium and röntgenotherapy may cure clinically, skeletal metastases of carcinoma. Case IX is clinically well and shows no recurrence in other regions of the body for two and a half years.

So it is observed that the Röntgen ray signs are very dependable, and if we wish to differentiate vague gastro-intestinal symptoms it is necessary to resort to the X-ray.

The Röntgen ray signs should be given careful consideration since the sequelæ to a long-standing patulous appendix are many. There is always a possibility of gastric or duodenal ulcer developing, since the reflex disturbances of the stomach, namely, hyperperistalsis, spasm of the pylorus and duodenum, and the resulting hyperacidity, all tend to create a favorable condition for the developing of ulcer. Also if there occurs a chronic infection of the appendiceal mucosa there is a possibility of secondary infection of the gall-bladder, resulting in a chronic cholecystitis. Lastly, there are invariably established numerous reflex paths which, even though the appendix has been removed, often require considerable patience and skill to overcome. It is also true that fecal material lying in the lumen of the appendix is liable to harden and produce ulceration of the mucosa and a discharge of pus into the cæcum. If the pus drains out readily there will be no leucocytosis or local symptoms. This fact explains why, in many instances, the local signs and blood picture are negative, even though there is infection of the appendiceal mucosa. However, as a rule, in these cases the reflex phenomena are profuse. In one case of patulous appendix the only complaint was frequent attacks of colic. At operation no inflammation or anything distinctly pathological of this appendix could be observed. But on opening the appendix it was found filled with hook-worm. This explained the colicky attacks. In a case of recurring attacks of amœbic dysentery the removal of the patulous appendix was followed by a complete disappearance of the infection.<sup>3</sup> The appendix, in this case, probably acted as a focus from which amœbæ escaped from time to time, producing a recurrence of symptoms.

From the Röntgen ray standpoint the life cycle of a patulous appendix is divided into three stages:

First, hyperperistalsis of the appendix with no stasis.

Second, partial failure of peristalsis of the appendix with partial stasis.

Third, complete or almost complete failure of peristalsis of the appendix with complete or almost complete stasis.

The duration of the stages is variable. The first stage may last during the entire lifetime of the patient and produce no signs except the vague symptoms that are mentioned in the text. Or it may go into the other stages at any time and produce marked symptoms. The passage of the first into the other stages occurs by three different

# THE SIGNIFICANCE OF THE PATULOUS APPENDIX

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RÖNTGENOLOGIST AT THE CHARLOTTE SANATORIUM AND CROWELL UROLOGICAL CLINIC

THE patulous appendix is grossly classified into two types, viz.: functioning and non-functioning. It is generally conceded that the non-functioning type is pathological. The significance of the functioning type, however, is not so easily determined and there is a great diversity of opinion as to whether or not it produces symptoms.

Cohen<sup>1</sup> says that the cæcal contents normally pass into the appendix, and the probable reason that the appendix is not visualized is that it fills and empties between observations. However, if this is true, with our present technic, which includes the röntgenographic and fluoroscopic examination, it would be very easy to visualize the normal appendix in every case. Since this cannot be done, we are justified in saying that the cæcal contents do not normally pass into the lumen of the appendix.

Case<sup>2</sup> says the essential point to determine is, not whether the appendix fills, but whether it empties. A poorly drained appendix is a dangerous one. The writer agrees with this statement only in part. There is no doubt that the patulous appendix with stasis is pathological and should be removed, but this is a gross classification since the patulous appendix produces symptoms before stasis occurs. If the symptoms become marked, it may be necessary to operate, even though there is no stasis.

It is claimed that by firm pressure downward over the cæcum the appendix can be forced to fill, but I do not consider an appendix filled in this way pathological, as it has been filled artificially. Sufficient outside pressure exerted in the proper direction will overcome the mechanism that guards the appendiceal orifice and cause it to give way, producing a temporary appendiceal incompetency.

Clinically, with a negative history of colic, no leucocytosis or local signs it would be impossible to attach any blame to the appendix. Yet, röntgenographically, a finding of marked pylorospasm, hyperperistalsis of the stomach, and a patulous appendix, combined with a history of chronic gastro-intestinal disturbance and hyperacidity, the weight of the evidence would be sufficient to place the blame on the appendix.

gastric symptoms, occasional slight attacks of colic and local tenderness. It is during this stage that we first begin to think of a possibility of an abnormal appendix, although there is no leucocytosis or tenderness over the appendix, except possibly during the slight colicky attacks. The colic is a warning that there is now a beginning of more marked pathological changes. The appendix is not draining so well and the patient feels considerable discomfort until the appendix succeeds in emptying itself. There are now possibly concretions forming which are not expelled by peristalsis and catharsis. The catharsis acts by liquefying the fecal material so that it can more easily pass into the cæcum. As a rule, the patient always knows, by his previous experience, that catharsis temporarily relieves the discomfort produced by this complication.

The third and last stage, in addition to the gastric symptoms, is manifested by more marked local symptoms, such as tenderness over McBurney's point and leucocytosis. This is the stage when the peristalsis of the appendix has completely failed, the stasis being very marked and the appendix, instead of being an active organ with normal peristalsis, is dead insofar as peristalsis is concerned. At this time the surgeon does not need the aid of the X-ray for diagnosis.

It is absolutely erroneous to say that from a Röntgen ray standpoint we should be guided by drainage in determining whether or not a patulous appendix should be removed. Probably at the moment the röntgenogram is made the appendix will be observed draining nicely, but the same examination could be repeated in several days with the result that this same appendix would show considerable stasis. There are so many factors that rule out drainage as a dependable sign. If the patient permits himself to become constipated the drainage of the appendix will be poor. If he takes a purge the drainage of the appendix will be good. If fecal concretions occur these will interfere with drainage until they are expelled. So it is observed that drainage of the appendix is easily influenced by the habits of the patient. The dependable röntgenological signs are those that have been enumerated in this paper and it is a careful comparison of these with the clinical findings that will result in the most reliable diagnosis.

From the above study of the various stages of the patulous appendix it is observed that to a large extent the important witnesses of the damage being done by the open appendix are found in the stomach. They are hyperperistalsis, spasm of the pylorus and duodenum and delayed emptying time of the stomach. If coupled with these findings an open appendix is found, we are justified in saying it is pathological. If the ileocæcal adhesions are present these tend to strengthen our

## THE PATULOUS APPENDIX

routes, the first two being mechanical and the third functional, and are as follows: First, suddenly by an acute obstruction in the lumen of the appendix due to hardened fecal material. This complication would immediately usher the appendix from the first stage into the third. Second, gradually, this being effected by infiltration, thickening and contraction of the walls of the appendix, or by means of kinks and adhesions, all of which would produce stasis. Third, or the functional route, is also gradual, and is characterized by a wide lumen and scarcely no peristalsis. In this instance, it seems that the lapse into the third stage is due entirely to an almost flat failure of peristalsis, there being no acute obstruction, kinks or narrowing of the lumen to explain the stasis.

First, the stage of hyperperistalsis of the appendix with no stasis. The röntgenographic evidence of this stage is present in both the stomach and ileocæcal region. In the stomach there is observed hyperperistalsis and marked spasm of pylorus and duodenum. In the ileocæcal region the evidence is the open appendix with no stasis. During this stage the röntgenographic finding is a marked frequency and great force of the peristaltic waves of the appendix. It is also observed that the appendix moves freely, assuming various shapes and positions in its efforts to empty. This unusual activity, I believe, is explained by the entrance of fecal material into the appendix, which acts as a foreign element and causes an abnormal stimulation of the peristalsis, and if it is assumed that the appendix has a parasympathetic innervation the hyperperistalsis could be explained by an abnormal stimulation of these nerves.

The clinical symptoms during the first stage may be either mild or severe and are almost entirely reflex. It is very seldom that the slightest local tenderness can be detected. The gastric symptoms, however, are predominant. These are discomfort, or even tenderness over the pyloric and duodenal area, eructation of gas, and flatulence. During this stage, as long as the gastric symptoms are predominant, there is a hyperacidity of the stomach. During the other two stages the acidity is a variable factor, being normal, hypo- or hyperacid. On account of the constant stimulation from the leaking appendix it is observed that during this stage the reflex path to the stomach becomes so firmly established that a train of gastric symptoms results that is out of all proportion to the pathology of the appendix.

Second, the stage of partial failure of peristalsis of the appendix with partial stasis. This is the stage of beginning failure of compensatory hyperperistalsis and, clinically, we have present, in addition to the





FIG. 4 —Patulous appendix during the second stage. The peristalsis is not so vigorous, neither is the appendix so freely movable as in the first stage.



FIG. 5 —Same appendix as Fig. 4, two hours later. Note that the appendix still holds the horse-shoe shape, as in Fig. 4.



FIG. 6 —Patulous appendix of the third stage. At this time the appendix requires a number of days to empty the bismuth.



FIG. 1.—Patulous appendix during the first stage. Note that the appendix twines itself around the cæcum vigorously in an attempt to empty itself. An appendix of this kind invariably produces marked reflex disturbances of the stomach.

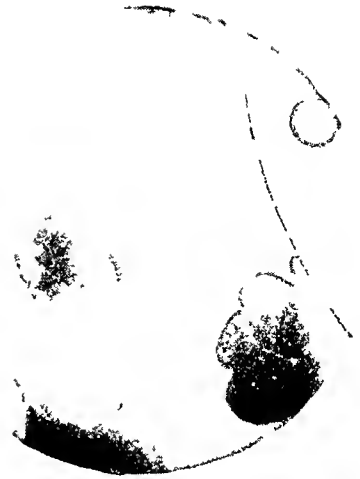


FIG. 2.—The same appendix as Fig. 1, two hours later. Note the appendix has changed its position and apparently the peristalsis is very energetic in its attempt to empty.



FIG. 3.—The same appendix four hours later than Fig. 1. Note that the appendix has again changed its position and the peristalsis is still very vigorous. It is during this stage that the gastric symptoms predominate.





FIG. 7.—Same appendix as Fig. 6, twenty-four hours after the opaque meal. Note the cæcum has almost entirely emptied itself of the contents but the appendix is still filled.



FIG. 8.—Same appendix as Fig. 6, thirty-six hours after the meal. Note that cæcum has entirely emptied itself, but the appendix remains filled. It is this type of the patulous appendix that gives sufficient clinical symptoms to make a diagnosis without the aid of the Röntgen ray.

# RENAL TUBERCULOSIS

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DURING the past few months the writer has seen a number of cases of renal tuberculosis, several of which exhibited features of sufficient interest to merit recording.

The first case shows that an almost generalized tuberculosis of the genito-urinary tract may be present without the production of any grave symptoms and that following radical removal of the chief foci, rapid, spontaneous retrogression of the disease in the remaining organs can take place.

Case number two proves the erroneousness of the teaching of some surgeons that tuberculosis of the kidney can be diagnosed by inspection and palpation of the organ at the time of operation. Indeed, bisection of the organ from pole to pole may fail to reveal the seat of an extensive tuberculous process. This point is worthy of emphasis, as the author has seen, in the last few years, several cases of renal tuberculosis which showed no evidence of its existence upon the surface of the kidney, but on section and examination of its interior a most advanced tuberculous condition.

The moral of this is, that the diagnosis of renal tuberculosis should be made prior to operation by the employment of the cystoscope, ureter catheterization and functional tests, and once having determined the diagnosis, its removal should be resorted to, irrespective of its normal surface appearance at the time of operation.

The third case indicates that an entire kidney may be destroyed by tuberculosis and exist for many years without producing any renal symptoms or change in the general physical well-being of the individual. This case also shows the advantage of kidney functional test in surgical renal conditions and at the same time shows that it is not fool-proof.

CASE I.—History (abstract) July 13, 1916. No. 2791. G. A., aged thirty-four, single. Referred by Dr. A. McGlannan. Complaint: Discharging fistula from scrotum.

*Family History.*—Negative, except that one brother died of "galloping consumption."

*Past History.*—Had diphtheria at the age of seven years, no other children's diseases. Had gonorrhoea three times, the first

diagnosis. The pathogenicity of the patulous appendix should not be measured entirely by drainage, but rather by the acuteness of the various röntgenographical signs that have been mentioned above.

My belief is that when the muscular contraction at the appendiceal orifice, the valve of Gerlach, the peristalsis, or whatever the mechanism is that guards the appendiceal orifice, first becomes incompetent there results a compensatory hyperstalsis of the appendix. And gradually, for some reason, probably the increased pressure of fecal material, there is a failure of compensation and the appendix can no longer empty. Then we are face to face with a late stage of appendicitis. It is on the same principle as the changes occurring in a heart lesion. There we first have a compensatory hypertrophy of the heart, later a failure of compensation. In the appendix we first have a compensatory hyperperistalsis, later a failure of peristalsis.

Conclusions: First, there is a röntgenological symptom syndrome associated with the patulous appendix, the detection of which is sufficient evidence of an abnormal appendix. Second, a patulous appendix, even though its drainage is good, is abnormal. Third, the röntgenological evidence of the damage being done by the patulous appendix is present in both the stomach and ileocæcal region.

## REFERENCES

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- <sup>2</sup> Case: *The American Journal of Röntgenology*, vol. ii, No. 3.
- <sup>3</sup> Personal communication, Drs. C. M. Strong and Oren Moore.

5 per cent. Left kidney appeared in nine minutes, first half hour 11 per cent., second quarter of an hour trace, leakage 20 per cent. Total output in three-quarters hour  $49\frac{1}{2}$  per cent. Urine: Centrifugalized catheterized specimen. Right kidney showed red blood-cells and epithelial cells, result of trauma. Left kidney showed red blood-cells, epithelial cells and pus cells. No tubercular bacilli on either side. A few strepto-bacilli on left side. Albumen positive from both sides.

*Diagnosis.*—Tuberculosis of right and left epididymis, prostate, right seminal vesicle, left kidney.

*Operation* (July 13, 1914).—Left kidney removed, oblique lumbar incision, by Dr. McGlannan, assisted by the author. Kidney larger than normal, both upper and lower poles were soft. Numerous tubercles present over the surfaces of the kidney. On section in both upper and lower poles there were numerous abscess cavities filled with pus. Several areas in cortex were involved. Pelvis somewhat dilated. Patient made an uneventful recovery and was discharged. Microscopic sections showed typical tuberculosis.

June 12, 1915: Patient returns saying that his weight reached one hundred and fifty-one pounds, but has recently dropped to one hundred and thirty-six. Has slight discharge coming from incision in scrotum on right side. Left side feels normal. Kidney incision healed. No cough, no burning, no frequency, urine practically clear, contains several shreds, albumen negative, pus negative. Prostate not increased in size, median furrow present. Right lobe of prostate soft, except one small area about the size of a pea which is indurated. The left lobe at the upper pole is slightly indurated. Right seminal vesicle somewhat large and indurated but smaller than before. Left epididymis feels normal in contradistinction to what it was before operation.

*Discussion of Case.*—Here is a patient with an advanced tubercular process of the left kidney, a tuberculosis of the bladder, prostate, one seminal vesicle, both epididymes, as well as an advanced phthisic condition, seeking relief from a small discharging fistula in the left side. Only a systematic interrogation of the entire genito-urinary tract by means of a careful examination of the urine, the employment of the cystoscope, ureter catheterization and functional tests revealed the true condition. Moreover, it reveals how a general physical debilitation may be overcome and how improvement and spontaneous arrest may be obtained in such important remaining organs as the lungs, bladder, prostate, seminal vesicles and epididymis by radical removal of the organ or organs most advanced or offending.

ten years ago and the last about a year and a half ago. In April, 1913, began complaining of ill health, and a diagnosis of pulmonary tuberculosis was made in December, 1913. Was then admitted to a sanatorium where he has remained until present time.

*Present complaint* dates back to one and a half years ago, when patient had his last attack of gonorrhœa. He then complained chiefly of frequent micturition, eight or ten times during the day and once or twice at night, and this condition has persisted to the present time. In November, 1913, noticed that blood appeared at the beginning of micturition; this lasted one week, and has not returned since. Has had burning during urination. While the force of stream has been good he has complained of hesitancy and occasionally the stream would be divided. Sexual desire was good until he entered the sanatorium, since then he has had none. Has no nocturnal emissions. Patient is nervous but sleeps well. Appetite was good until he was admitted to sanatorium. During the first few months there he lost 18 pounds. At first had cough, night sweats, and high temperature, but at present has none of these symptoms, present evening temperature is 99°.

*Examination.*—There is no discharge from meatus. Both the right globus minor and major feel nodular. The globus major is larger than the minor and tender and painful to touch. The globus minor is about the size of a pea; the major about the size of the end of the little finger. There is a fistulous tract leading down into the right epididymis. The left epididymis is enlarged slightly and feels nodular throughout. *Urine:* Glass 1 cloudy with shreds, glass 2 very cloudy. *Centrifugalized specimen:* Fresh specimen shows many pus cells, no red corpuscles, no organisms. Stained specimen shows no tuberculous bacilli or any other organisms, but many pus cells. Prostate not enlarged, median furrow present. On the right lobe can be felt two nodular areas about the size of small pea; one nodular area on the left lobe. Right seminal vesicle is enlarged and nodular and about the size of a lima bean. Left seminal vesicle palpable but apparently not involved. Bougie a-boule passed into bladder without meeting obstruction. Phenolsulphonephthalein injection given intramuscularly shows an elimination during the first hour of 43 per cent. and second hour 13 per cent. Cystoscopy July 13, 1916: Cystoscope entered with ease. Residual urine 15 c.c. Bladder capacity 450 c.c. No intravesical enlargement of prostate. Several ulcerated areas present in bladder. No stone or tumor mass present. Ureters seen and catheterized with ease; clear urine obtained from the right ureter and cloudy from the left. Functional test given intravenously: Right kidney appeared in ten minutes; first half hour 13½ per cent., second quarter of an hour



and was isolated for three weeks. During all this time bladder irrigations did not benefit markedly the pyuria. Following the attack of measles she was again cystoscoped (April 1, 1916). Bladder not so irritable, right ureter was seen and catheterized, showing normal urine in every respect and 50 per cent. phthalein after half an hour following intravenous injection 6 mg. Left ureter could not be catheterized and result obtained transvesically showed no function from that side. Diagnosis of dead left kidney and compensatory right kidney was thereupon made.

For the last few weeks she has been running slight temperature and normal respiration but the pulse has varied between 120 and 160. Blood count showed 32,000 leucocytes. There was tenderness in the region of right kidney but no pain in the left.

*Operation* (April 8, 1916).—Lumbar left nephrectomy. Ether anæsthesia. The kidney easily removed and showed only a large pus sac, full of pus, which, when washed out, left a kidney which was nothing but a large sac. No kidney parenchyma seen. Ureter sewed into a rubber tube and two gauze cigarette drains passed down. Patient returned to ward in good condition.

Third day: Patient running high temperature and rapid pulse. Both renal and suprapubic wounds draining.

Twentieth day: Patient has gradually been improving. Renal wound is healing nicely. When suprapubic wound closes, as it has done on several occasions, temperature is higher.

Four weeks: Temperature 99, pulse 116. Both wounds still draining but feels stronger. Patient sent home in weakened condition with both fistulæ draining.

Nine and a half months: Letter. Still very weak, kidney wound closed. Bladder fistula still open.

*Discussion of Case.*—As the patient's general physical condition was excellent, with normal pulse and temperature, a normal functional output, an entire absence of kidney symptoms during the five years of her complaint, it was decided for two reasons to do a suprapubic cystostomy, first, to make sure of the diagnosis, which was impossible on account of the unsatisfactory cystoscopy, and, second, it was believed that vesical drainage would be helpful if a mere cystitis was present, particularly as all symptomatic treatment had been futile up to this time. At the time of operation (suprapubic) the small, thick, contracted bladder gave us our first suspicion of tuberculous cystitis. Following the bladder drainage, the painful symptoms subsided materially, but the failure of the urine to show marked improvement indicated an involvement of the one or both kidneys. The patient began after the operation to lose weight and developed a septic temperature and rapid pulse out of

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CASE II (December 28, 1915).—History No. 3955. Diagnosis: Tuberculosis of left kidney, tubercular cystitis. Miss E. R., aged eighteen, referred by Dr. O. O. Cooper, Hinton, W. Va.

*Family History.*—Father died of tuberculosis, nothing else of importance.

*Past History.*—Negative to all diseases except diphtheria. Has had bladder trouble for five years.

*Menstrual History.*—Menstruation started at the age of sixteen years, but was very irregular, occurring as a rule about every two months; flow very scanty and lasted only a few days.

*Present Complaint.*—Began five years ago when patient noticed blood in her urine. At the same time she had frequent urination, voiding every few minutes, both day and night. When the desire to void came on she would urinate just a few drops each time with a burning, stinging sensation, she would also strain a great deal, causing a slight terminal hæmaturia. If she withheld her desire to void the urine would dribble away. Several times she had incontinence in bed at night. During the past five years these symptoms have become aggravated. Two cystoscopic examinations were made and she has been treated without getting relief. Was told she had a bladder tumor and needed an operation. Has lost about five pounds in the past few months.

*Examination.*—Urine is very cloudy; microscopic specimen shows many pus cells and a few red blood-corpuscles, albumin +++, no sugar. Cystoscope enters with ease. No residual urine. Trigone much inflamed and thick masses of pus are seen on trigone and around ureters. No evidence of stone or tumor. Few trabeculations present. Ureters not catheterized, as they cannot be seen. Phthalein test 50 per cent. one hour after intramuscular injection.

*Operation* (December 29, 1915).—Suprapubic cystotomy performed in the usual way. As the bladder was approached the superior wall felt very hard, but not nodular, having the feel of a bladder tumor. An incision was made into this and it was found to be due to the thickened wall. No ulcerations were found in bladder, no stone nor tumor. Trigone looked very much inflamed. Tube was inserted and after three days drainage continued with Davis drainage tube.

January 5, 1916: Patient is weak, urine much clearer.

Bladder draining (February 15, 1916): Patient has been in bed since operation. Feels much stronger and suprapubic wound looks well. Drainage has been kept up and urine looks much clearer. Cannot void through urethra yet.

April 8, 1916: Following suprapubic operation, the pain in suprapubic region disappeared or improved, but the urine remained full of pus. Patient developed measles while convalescing

cough in morning. Is restless at night and several times has had night sweats. No chills or fever. Sexual desire normal, no nocturnal emissions. Examination: External genitals normal, no discharge. Testicles normal, inguinal glands normal, meatus small. Urine glass 1 and glass 2, very slightly cloudy and contains a few shreds. Microscopic examination shows the presence of pus without organisms by the ordinary staining methods. Phthalein test shows an output of 60 per cent.

January 6, 1916: Cystoscopy. Cystoscope enters with ease, no residual urine. Bladder capacity about 500 c.c. Tone good. No intravesical enlargement of prostate. Trigone normal. No trabeculations. On the superior wall of bladder is a small ulcer about the size of end of little finger. Edges red, base looks fairly healthy. Ureters seen after injection of 2 c.c. of a 4 per cent. indigo-carmin and left ureter catheterized. Catheter could only be gotten up about  $\frac{3}{4}$  inch in right ureter. Centrifugalized urine from left ureter showed no pus cells, red blood-corpuscles from trauma. Indigo-carmin appeared on both sides in 7 minutes.

January 13, 1916: Cystoscoped again with same results.

February 4, 1916: Cystoscoped third time, unable to catheterize right ureter. In attempting to do so, used a small calibre bougie to see if same could be entered and mucous membrane at ureteral orifice was punctured. An intravenous injection of phthalein was given and 35 per cent. was collected from left ureter, 30 per cent. was collected transvesically, but there was leakage beside the left catheter.

April 2, 1916: Meatus very hard and indurated. Meatotomy performed and patient again cystoscoped. Left ureter catheterized with Garceau catheter. Indigo-carmin 4 per cent.,  $\frac{1}{2}$  c.c. given intravenously appeared in seven minutes. Indigo-carmin cleared both sides in one and a half hours. Phthalein given intravenously appeared in three minutes on the left side and five minutes in bladder urine. Found no leakage beside catheter this time. Output first half hour from left side 34 per cent., output first half hour from bladder urine 25 per cent.

On two occasions patient was examined for tubercle bacilli and on both occasions numerous clumps of bacilli were found. Strict precautions were taken regarding technic for obtaining same.

*Operation* (March 13, 1916).—Right kidney exposed in the usual way through lumbar incision (oblique). Kidney was easily and rapidly delivered, no adhesions were present. On exposure of kidney the size, shape, color and consistency seemed normal in every respect. Kidney was then bisected at a point a little behind its middle. Careful examination of interior of kidney showed no evidence of tuberculosis whatever. However, on account of

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all proportion to the interference instituted. We waited until December 29, 1915, for her pulse and temperature to improve before attempting another ureter catheterization. This time we succeeded in catheterizing the right ureter, but it was impossible to see the left. Accordingly the urine and function from the left was obtained transvesically through a catheter introduced into the urethra. We were surprised to find the urine coming from the right kidney perfectly clear and free of all pathological elements. Phthalein test from this side showed an output of 50 per cent. The output from the left side obtained transvesically was nil. The diagnosis of an advanced left pyonephrosis was now easily made, with a compensatory hypertrophy of the right kidney. The combined functional test being normal tended with the absence of the other kidney symptoms to exclude renal involvement. Its value was more than ever emphasized to me, even if it was not fool-proof, and was the only factor which made possible the true diagnosis. The development of pain over the region of the right kidney was misleading and a colleague suggested that I might have been mistaken in the ureter catheterized and thought if she had a kidney involvement it must be, on account of this pain, in the right side. As already indicated the kidney was entirely destroyed, its remnant being a large membranous sac filled with purulent material. It seems most curious that a large pus sac of this size could lodge within the interior of the abdomen for so many years without producing any symptoms referable to it. As the patient has had bladder symptoms for five years, it is obvious that the kidney condition must have existed considerably longer. It is also worthy of notice that the patient's general physical condition, which up to the first operation was excellent, was greatly interfered with and was not even benefited after the removal of the offending kidney.

CASE III (January 4, 1916).—No. 4073. J. H. W. History (abstract), aged forty-one. Referred by Dr. E. H. Hutchins.

*Family History.*—Negative except that his wife died of tuberculosis.

*Past History.*—Had the usual diseases of childhood, including scarlet fever. Says he had remittent fever fourteen years ago. No gonorrhœa or lues.

*Present complaint* dates back to the first part of September, 1915, when patient noticed a burning sensation at glans penis at the end of and following micturition. This gradually became worse. At that time voided about every hour during the day, very seldom at night. At present still voids about ten or twelve times during the day, also several times at night. These were practically the only symptoms. Patient has fair appetite. Has slight

the kidney. The opening up of the pelvis demonstrating not only tuberculosis, but an advanced process therein, proved the soundness of the judgment, which could only have been obtained by conviction based on the employment of careful study preliminary to operation. Secondly, the case is interesting in the presence of an advanced and extensive process in the pelvis and only a slight involvement of one renal papilla. Tuberculosis of the kidney is usually hæmatogenous in origin and the disease is usually initiated by the deposit of fine and infective emboli in the finer terminal arterioles and capillaries of the organ. The usual seat of the disease is scattered more or less widely through the substance of the cortex and parenchyma. Pelvic involvement is secondary and occurs as a result of the extension of the process by a direct continuation of tissue. It is noteworthy, therefore, that the disease began in the pelvis rather than in the cortex or parenchyma. The seat of the disease also explains the equal time appearance of indigo-carmin and illustrates beautifully the sensitiveness of the phthalein test. As there was only a very slight involvement of the renal secreting substance, there was only a correspondingly slight reduction of the phthalein output as compared with its fellow. The almost clear urine was also a singular feature. The ulceration at the meatus resisted all local treatment and behaved clinically like one would expect with a tuberculous ulceration. We were convinced of its tuberculous nature and were surprised at the pathologist's report being non-tuberculous. This feature would seem to indicate the need of trying to avoid meatotomy in suspected cases of genito-tuberculosis. For various reasons, I have done meatotomy many times and have never observed this complication before. Inquiring among several colleagues has brought the response that they have never witnessed such a complication in their experience.

CONCLUSIONS.—While it seems utter folly to attempt to draw any conclusions from so few cases, nevertheless, each represents a type that we are constantly encountering and makes the following ones justifiable and worthy of consideration.

1. A more or less generalized genito-urinary tuberculosis may be present with practically no symptoms.
2. Removal of the most advanced or offending organ or organs where possible may lead to the spontaneous arrest of the remaining ones.
3. Exploratory diagnosis of renal tuberculosis by inspection and palpation at the time of operation is entirely erroneous; indeed it is possible that bisection of the kidney from pole to pole at the time of operation may fail to reveal the site of the infection.
4. Tuberculosis of the kidney may exist in an advanced degree for many years without causing any symptoms referable to it.

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difference in function on the two sides and the probable stricture of the right ureteral orifice, it was believed that there must be somewhere in the kidney a tuberculous process. Because of this the kidney was removed in the usual way. The ureter was tied as low down as convenient, touched with pure carbolic and then pulled up inside of a rubber drainage tube and anchored there. The wound was then closed around the tube after two pieces of iodoform gauze were placed around in the usual way.

Examination of the kidney after removal, on cutting it so as to expose the pelvis, showed a thickened oedematous condition of the lower half of the pelvis and upper part of the ureter. Everywhere the pelvis shows ulceration and is covered with caseous deposits. On more minute examination many small, irregular-shaped and sized tubercles are found. At the lowest end of the pelvis, at a point where the last two pyramids communicate, a definite tuberculous ulceration is present, which probably invades the apex of the pyramids at that point. Situated at the middle of the kidney on the right side is a small area of caseation about the size of a three-cent piece. It is circular in outline and the base is definitely caseous. The rest of the kidney looks normal macroscopically.

Blocks made from pelvis, from lower pole at point where last two or three pyramids communicate with pelvis, and from small tuberculous area felt in middle of kidney extending from pelvis, showed typical tuberculosis. Section from ulcerated meatus showed inflammatory ulceration.

*Diagnosis.*—Tuberculosis of right kidney, right ureter and bladder. Stricture of right ureteral orifice.

*Discussion of Case.*—This case reveals several points of practical importance. The diagnosis of right kidney tuberculosis was based on the strictured condition of the right ureter orifice, the lowering of the function, as compared with its fellow, early tuberculous ulcerations in the bladder and the demonstration in the urine of tubercle bacilli. At the time of operation, having been convinced of the diagnosis and the knowledge that surface appearance of the organ warranted no conclusion against its being tuberculous, I would have removed it without hesitation. But out of deference to the suggestion of Dr. Hutchins I bisected it from pole to pole, beginning my incision as is usual, a short distance behind the middle line, with the consequence that the division brought us outside the pelvis. At this stage, with all findings still against tuberculosis, the supposition seemed an erroneous diagnosis and the need of replacing the kidney within its bed appeared necessary. It was only after a discussion of the facts which led up to the diagnosis in which several other surgeons took part, that it was decided to remove

it relapses into a rudimentary structure known as Gartner's duct. Each of the offshoots mentioned becomes a ureter, the bud growing and dividing distalward until pelvis, calyces, and straight uriniferous tubules are all produced. Surrounding each bud, developing and ascending with it, is an independent group of cells of different origin—the renal blastema—which forms the secreting portion of the kidney.

Simultaneously further differentiation has been progressing at the lower end. The urorectal septum has now definitely separated bladder and rectum and the ureter itself, originally opening into the Wolffian duct, halts short of the caudalward travel of its parent so that the terminal orifice of the latter eventually lies anterior (in the urethra) and the latter posterior (in the bladder). Numerous possibilities are here opened, as Kelly notes. If the Wolffian duct and ureter fail to shift anteriorly from the cloaca before the urorectal septum grows down to divide the rectum from the bladder, the ureter opens into the rectum. If the ureter does not separate itself from the Wolffian duct, but accompanies that canal in its journey caudalward, there results abnormal connection of the ureter with those organs which arise from the duct, or else with the sinus urogenitalis and the organs developing out of this—the upper portion of the urethra in both sexes and the vestibule of the vagina in women. Finally, if the ureter does not remain isolated from the closely related Müllerian duct, it is attached in women to the uterus or the vagina. Some of these anomalies have been reported and have offered opportunity for ingenious surgery.

As for the ureter at its upper end, it may branch precociously, producing a Y-shaped canal, each limb leading to an independent pelvis, or there may result anomalies of lesser note with individual large calyces, pelves of unusual shape and so on to a theoretically unending degree. When the division occurs some distance below the kidney and there are definitely two pelves, the condition has an important surgical bearing. W. J. Mayo has successfully bisected several kidneys of this type.

None of these considerations explain the ureter duplicated throughout its entire extent with an independent pelvis at one end and an independent bladder orifice at the other. Various theories have been advanced. That the condition represents a third kidney or a fusing together of two kidneys on one side is no longer believed. True supernumerary kidneys are extremely rare and possibly do not exist at all. In all likelihood the simplest explanation is the best—that there is a double evagination from the Wolffian duct instead of one, or that the division of the single bud begins so close to the Wolffian duct as to appear as two separate outgrowths. One bud is situated higher than

## REDUPLICATION OF THE URETER\*

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WHEN one fully appreciates the complexity of the embryologic process which finally deposits the normal kidney in its permanent resting place in the lumbar fossa, together with the associated and simultaneous readjustment of structures at the lower end of the ureteral tract, he will not fail to bear in mind the possibility of an anomalous element in any unusual clinical picture involving the urinary apparatus.

As a rule, we are too prone to predicate all our diagnostic premises on basic anatomy and to overlook the possibility of aberrant types. As a result of its tortuous embryology, the kidney is peculiarly liable to maldevelopment in one form or another. In fact, as noted by C. H. Mayo, anomalies in the genito-urinary system are more frequent than in any other part of the body. This fact, with its medical and surgical significance, is not sufficiently appreciated, particularly as concerns the anomalies of lesser degree. Horse-shoe or ectopic kidneys, for instance, have become more familiar to the average surgeon than realization of the fact that a third ureter may lead the way out of a puzzling situation or that a duplicated pelvis may not only contribute an etiological factor, but at the same time invite a conservative surgical remedy. Kelly and the Mayos, the latter with the able assistance of Braasch, have done much to open up this field.

*Embryologic Basis of Anomalies.*—The present report considers only one form of anomaly—the supernumerary ureter—and is further limited to that type of it which presents a bladder orifice at one end and an independent pelvis at the other.

Reference to the developmental stage will explain the malformation. At an early period the future rectum and bladder are represented by a common reservoir, the cloaca, which soon becomes divided into an anterior and a posterior segment. The latter finally becomes the lower end of the rectum and need not be further considered. The ventral compartment eventuates as the bladder and urethra and has attached to it two canals—the Wolffian ducts—each of which sends forth an offshoot and then in addition thereto proceeds to form in the male the head of the epididymis of the corresponding side, and also the vas deferens, the seminal vesicles, and the ejaculatory duct. In the female

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\* Read at meeting of Medical Society of Virginia, at Norfolk, October 26, 1916.



interval prevails they are farther apart, so far that the upper ureter may be carried to or below the internal urethral orifice" (Kelly).

In our cases the orifices were always close together. Reference to Kelly's diagram (Fig. 1) will show that the ureters must cross each other and that the ureter from the upper part of the kidney must have a vesical orifice below and medianward to the orifice of the ureter coming from the lower part of the kidney. Our cases, however, differ slightly from those of Kelly and coincide precisely with those of Braasch who also notes that when complete duplication of the ureter exists there will be not simply one point of crossing, as stated by Kelly, but two—the first crossing occurring a short distance below the ureteropelvic juncture and the second a short distance above the bladder wall. Consequently the appearance would be as indicated in the pyelograms appended.

#### REPORTS OF FOUR CASES

CASE I.—Mrs. F. F., aged twenty-four, white, married four years; was delivered with forceps on June 10, 1910, with great difficulty. For two or three weeks she got along very well and then began to have an irregular fever which would go as high as 103 or 104 and then subside for an interval. This brought her to the hospital in August of the same year. Bladder disturbance was conspicuous by its absence, with the exception of a disagreeable odor to the urine and a large amount of microscopic pus. Locally a slight tenderness in the right loin was all that could be elicited. Cystoscopic examination showed nothing essential so far as the bladder was concerned. Right and left ureters were catheterized and the specimens were entirely negative. The diagnostician was nonplussed. Moreover, pus continued to appear in the urine and the patient to exhibit still more marked general signs of a pyelitis, which had been originally assumed to be the cause of her trouble. A second cystoscopic examination cleared up the mystery. A third ureteral orifice was now found on the right side and when catheterized promptly exonerated the diagnostician and revealed the source of the pus. Treatment directed toward this anomalous ureter caused rapid improvement in the patient, who, so far as known, has since been well. Unfortunately full notes were not made in this case and no X-ray plates were taken.

CASE II.—Miss M. G., white, unmarried, aged thirty, came for consultation on November 19, 1913, with a history of indigestion, constipation, and right-sided abdominal pain and soreness suggestive chiefly of appendicitis, though possible involvement of gall-bladder or pylorus could not be definitely excluded at this time. In addition she suffered with menstrual disturbances, the cause for which was revealed in a markedly retrodisplaced and somewhat

## REDUPLICATION OF THE URETER

the other. The ureter which develops from the lower reaches the bladder first, usually in the place where the normal single ureter is found; "the upper continues its downward shifting together with the

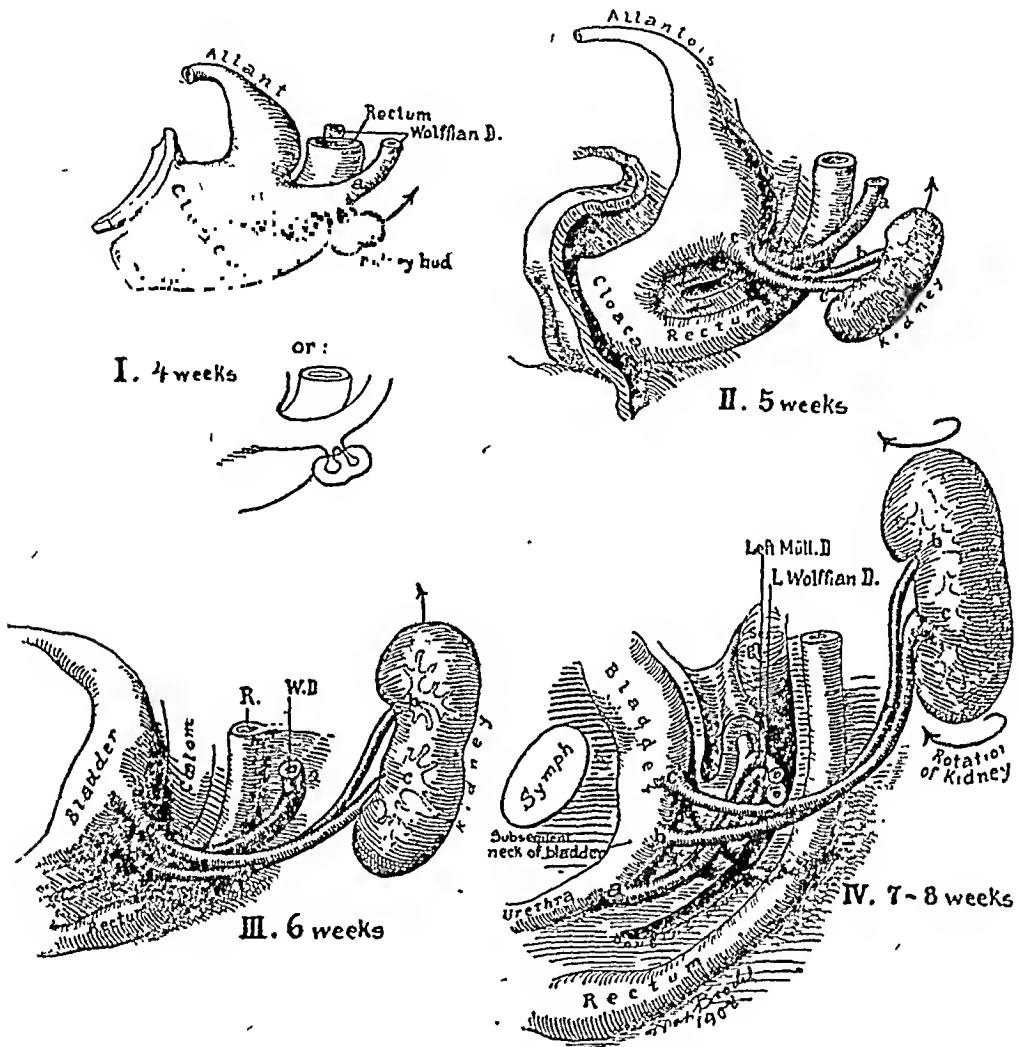


FIG. 1.—Kelly's diagrams and explanatory notes: Four diagrams illustrating the development of a kidney with divided pelvis and double ureter. The figure shows why the ureters cross and why the upper pelvis and ureter drain into the lower vesical orifice, while the lower pelvis and ureter drain into the upper vesical orifice. I, the double ureter starts from the Wolffian duct, *a*, either as two separate anlagen, *b* and *c*, or as an original single anlage showing a precocious branching which resembles a double anlage. II, through expansion of the lateral portion of the allantois, the lower Wolffian duct becomes dilated and the lower ureter, *c*, is the first to reach the allantois. The Wolffian duct, *a*, carrying the upper ureter, *b*, with it, shifts with the urogenital sinus, in a downward direction, between the allantois and the rectum, as shown by arrows, until the second ureter, *b*, also becomes implanted in the bladder, but further down and more mesially than the first, *c*. III, we here see a continuation of the same process of advance of the Wolffian duct with a greater separation of the duct from the ureter. IV, the Wolffian duct continues to travel downward with the advance of the urogenital sinus and finally becomes permanently lodged at the neck of the bladder, *a*, in the male; in the female, it continues still further down. This last picture represents the final arrangement, as seen in the adult. Note that the original order, *a*, *b*, *c*, as shown in first picture, is now reversed to *c*, *b*, *a*, at the bladder. (From "Diseases of Kidney, Ureter and Bladder," Kelly and Burnam, vol. ii, pp. 332-333, D. Appleton & Co., Publishers).

Wolffian duct, mesially to the first attached ureter, until it also reaches the urogenital sinus. The Wolffian duct, minus the ureters, continues to shift to a still lower level. If the two ureters are liberated in quick succession they will be found close together in the bladder; if a longer

other. Evidently it was this rudimentary pelvis which was the seat of the original pyelitis and which was irrigated at the first examination, thus accounting for the tardy flow of urine noted at that time and the small amount of argyrol that could be injected. The subsequent history of this patient, up to the present time, has been entirely uneventful.

CASE III.—Mrs. M. C., aged thirty-eight, white, widow. In 1908 she underwent an emergency operation in another city for appendicitis, but the only pathology discovered was a nest of adhesions in the left side which were separated. The surgeon failed to find the appendix.

Two years later she came complaining of frontal headache, backache, nervousness, and lower abdominal pain, for which she was referred for medical treatment. Six months later she returned, having had an attack of vomiting, diarrhoea, urinary disturbance, and severe right-sided pain extending from kidney area to neck of bladder. The records show that a cystoscopic examination was made at this time and that "both ureters were discharging freely." The third ureter on the right side was not discovered. Urinalysis then and subsequently showed albumin, urates and pus.

One year later (1912) the patient reappeared, this time with headache, vomiting, anorexia, severe pain in her right flank and marked tenderness over the kidney and in the costovertebral angle. Her urine was cloudy but her bladder disturbance had subsided. A diagnosis of post-cæcal appendicitis or pyelitis was made, and through a right rectus incision her appendix was removed and some more adhesions were separated. After a stay of several weeks in the hospital she left "recovered." Two months later she returned with hemorrhoids, which were sutured, resulting also in "recovery." In less than six months all her old complaints revived—right-sided pain, headache, bladder disturbance, bearing down in region of right kidney. She also now suffered with indigestion and severe constipation. Urine contained a few pus cells. This condition continued until March, 1913, when a final diagnosis of chronic colitis with adhesions was made. Operation was done by Dr. J. C. Bloodgood and consisted of removal of a thickened and adherent cæcum and ascending colon, with anastomosis between ileum and transverse colon. Constipation now changed to diarrhoea, but in the main the patient's condition improved for a few months. After this she relapsed. Pain and tenderness in her right side continued and grew worse. For nearly two years she continued a chronic invalid, her chief complaint being referred to her bladder and right kidney area. Cystoscopic examination (the first by the writer) again failed to reveal the third ureter but disclosed a cystitis which was treated locally.

## REDUPLICATION OF THE URETER

enlarged and boggy uterus. Urinary history was negative. Operation was advised but was deferred one year, at the end of which period of reflection patient returned (November 2, 1914) with the same history accentuated and with the addition of a spell of fever, some left hypochondriac pain and a brief attack of bladder disturbance. Operation was now done, the appendix removed, and the retrodisplacement corrected. During a normal convalescence in the hospital the patient suddenly developed acute left-sided pain, fever, and a large amount of pus in the urine. Cystoscopic examination showed congestion of the base of the bladder with œdema and swelling around the left ureteral orifice. Right and left ureters were catheterized, specimens obtained, and kidney pelves irrigated with argyrol. At this time it was noted that the flow of urine on the right side was free and on the left very slow; also that but a small amount of the argyrol entered the left pelvis. Specimens showed pus on the left side with normal urine on the right. The patient made a prompt recovery and soon thereafter left the hospital. Two months later her urinalysis was practically negative.

In September, 1915, the patient brought her sister in for a slight operation. At this time her own health was excellent, digestive and menstrual disorders had ceased and her only complaint was slight pain in her back and mild bladder disturbance at the time of her monthly periods. Advantage was taken of the opportunity to again inspect her bladder to determine if any evidence was left of the antecedent pyelitis. The bladder was now entirely normal and the picture at the left angle of the base of the trigone was no longer obscured by œdema and swelling. It was then noted for the first time that two distinct ureteral orifices were situated at this point, separated about one-quarter inch from each other. All three ureters were catheterized and specimens obtained. Each ureter appeared to have a dripping schedule independent of the other two. A colored solution injected through one of the left catheters to the point of distention of the pelvis (pain) failed to return through the other left catheter, suggesting independent pelves. All three specimens were negative on microscopic examination, with the exception of a small amount of blood, probably traumatic, from the distal ureter on the left side. Two days later a collargol pyelo-ureterogram was made with leaded catheters. The plates (Figs. 2 and 3) showed the tip of the right catheter about three inches below the pelvis, which was only partially filled, two calyces showing. On the left side each catheter ran directly to an independent pelvis which had no connection with its fellow. The median ureter on this side crossed the lateral ureter a short distance above the bladder and recrossed it a short distance below the pelvis, which was higher placed and much smaller than the



FIG 6.—Lower urinary tract of Case IV. Upper point of crossing of ureters appears in this case to occur at much lower level than in other two cases. (X-ray work by Dr. A. L. Gray, Richmond, Va )



FIG 7 —Upper urinary tract of Case IV. Note unusual normal size and shape of duplicated pelvis. For purpose of clearer reproduction, outline of upper pelvis in this picture was retouched by the artist in strict accordance with original print and plate in our possession. (X-ray work by Dr. A. L. Gray, Richmond, Va )



FIG. 2.—Lower urinary tract of Case II, showing three ureters with radiograph catheters *in situ*. Note two points of crossing of duplicated ureters, as explained in text. (X-ray work by Dr. A. L. Gray, Richmond, Va.)

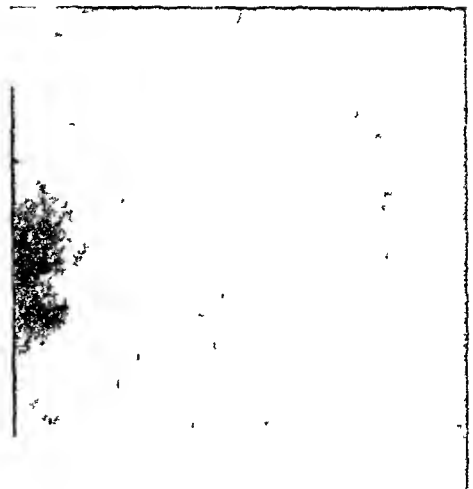


FIG. 3.—Upper urinary tract of Case II. On right side pelvis is incompletely filled, two calyces showing. On left side is beautifully shown upper point of crossing of duplicated ureters, each leading to an independent pelvis, the lower being entirely normal and the other typically rudimentary in appearance. (X-ray work by Dr. A. L. Gray, Richmond, Va.)

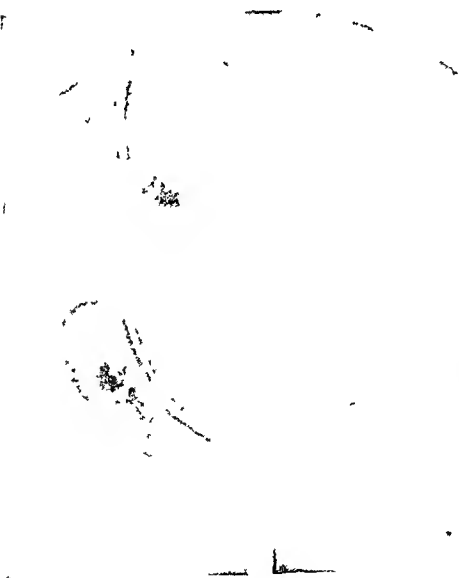


FIG. 4.—Lower urinary tract of Case III. The original pyelogram of this patient showed two points of crossing of ureters, as in Case II. The picture here shown, together with the one following, was taken very recently, and is selected because the outlines are clearer. The third point of crossing visible at this time is evidently due to displacement of one of the ureters by the dilating bougie. (X-ray work by Dr. A. L. Gray, Richmond, Va.)

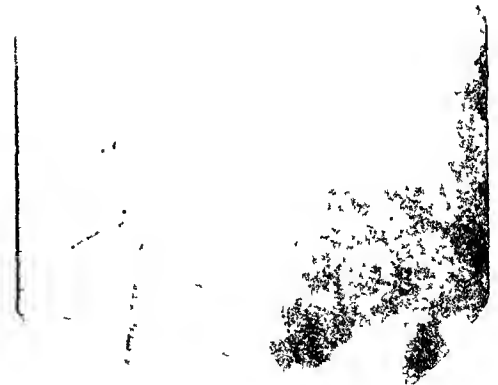


FIG. 5.—Upper urinary tract of Case III, showing two pelves, one of them being distinctly rudimentary in size and contour. (X-ray work by Dr. A. L. Gray, Richmond, Va.)

lous type. Left ureteral orifice somewhat displaced outward but otherwise normal. Right orifice buried in a nest of small bullae. On closer inspection of right side two distinct orifices were noted, one being situated slightly anterior and medianward to the other. Catheters were carried through both orifices for the full distance. Urine from one right ureter differed from the other in both color and dripping schedule. Collargol pyelo-uretrogram showed complete reduplication of ureters (Fig. 6) and independent pelves (Fig. 7). The supernumerary pelvis appeared more nearly normal in size and shape than the others in this series. Laboratory reports on specimens of urine were as follows:

Bladder: Specific gravity, 1010; reaction acid, albumin, pus, red blood-cells, and epithelial cells. Stained slides negative for bacteria.

Left ureter: Microscopic negative. Stain negative. Culture negative.

Right median ureter: Few pus cells. Stain negative. Culture negative.

Right lateral ureter: Definite amount of pus. Stain negative. Culture showed growth of staphylococci.

Review of the case appeared to justify the diagnosis of cystitis secondary to pyelitis limited to the right side and probably to the pelvis attached to the right lateral ureter.

Under treatment, consisting of lavage of the renal pelves with silver nitrate solution, iodoform emulsion injections into the bladder, and the usual internal medication, the patient made a very satisfactory recovery.

*Significance of this Anomaly.*—In presenting this report our object has been mainly to call attention again to the importance of a careful cystoscopic review of any renal condition. We have no delusions as to the importance of the exhibit as announcing anything extraordinary. While bilateral complete duplication of ureters is very rare, unilateral complete duplication is by no means uncommon. Braasch has reported several instances and the literature contains fairly good records of many more. Very recently (*J. A. M. A.*, May 27, 1916) Simon and Mertz, of La Porte, Ind., have cited one case with an excellent discussion. Cases II, III and IV in our list have occurred in a series of 100 patients with renal disease who have been subjected to cystoscopic examination during the past two years. Case I does not properly come in this series. It is taken from the office histories of my associate and chief, Dr. Charles R. Robins, and is added so as to give a complete record of our experience with the anomaly.

Not only do we not regard unilateral reduplication of the ureter as rare, but we are convinced that it is far more common than even the

## REDUPLICATION OF THE URETER

About two weeks later another cystoscopic examination was made (January 20, 1915) and at this time a double ureter was located on the right side, the small pin-point orifice of the second opening being situated slightly in front and to the median side of the orifice previously catheterized. Microscopic examination of the specimens showed a small amount of pus and blood from each of the right ureters; the left side was negative. Some time later pyelograms were made. The left kidney was in normal position with a pelvis of normal size and shape. On the right side (Figs. 4 and 5) were clearly outlined two ureters independent throughout, not communicating at any point. The lateral ureter led to a lower pelvis and the median ureter to a pelvis higher situated, both pelvic shadows being atypical. Function of the left kidney (phenolphthalein intravenous injection) was 13 per cent. in fifteen minutes (normal 15 per cent.); right lateral ureter 9.5 per cent.; right median ureter 1.2 per cent.; leakage into bladder 7.5 per cent. The three ureters and pelvises were catheterized and irrigated three times. The patient was free of right-sided pain and bladder disturbance for more than twelve months. She has recently developed a recurrence and we have just succeeded in again dilating the supernumerary ureter which had re-contracted to such a degree that it would at first admit nothing larger than a fine filiform bougie. We have also enlarged the pin-hole orifice by splitting it up with ureteral scissors.

CASE IV.—J. N. C., white, male, married, aged twenty-four years, entered the Memorial Hospital in our service on December 21, 1916, two months after the presentation of this paper in its original form.

Ten weeks previously the patient began, for the first time in his life, to have frequent micturition, burning during the act, and tenesmus following it. Occasionally he saw a little blood after he had been straining a good deal. Following the onset of the trouble all symptoms persisted, the burning and tenesmus becoming a little worse, but the frequency a little better.

Patient had no other complaint, and there was no history of previous similar attacks. Sometimes he had slight indigestion, characterized by fulness after eating, but this did not occur often; no nausea, no vomiting, some tendency to constipation. He had no pain. A year ago he was in bed two weeks with pneumonia and several months ago he had a spell of "malaria" with chills and fever. He denied venereal disease of any sort. At the time of his appearance in the hospital his general health was good, he felt strong and vigorous, was keeping up his weight, and would have considered himself well if he could be rid of bladder disturbance.

General examination negative. Prostate negative. Posterior urethra negative. Bladder showed violent diffuse cystitis of bul-



## ISOLATED SPRAIN-FRACTURE OF THE TRAPEZIUM PRODUCED BY INDIRECT VIOLENCE

BY J. L. BENDELL, M.D.

OF ALBANY, N.Y.

THE occurrence of isolated fracture of a carpal bone with the exception of the scaphoid is rare,<sup>1</sup> and except in crushing injuries of this region, fracture of the trapezium is extremely rare.<sup>2</sup>

The production of fracture of any member of the bones of the carpal group by any mechanism other than by direct violence is of such novelty that it may be looked upon as possible, but highly improbable.

Isolated fracture of the trapezium produced by forcible internal rotation of the wrist-joint is a lesion of such unusual occurrence that it has prompted the present communication.

The lesion *per se* is rare, and in this instance, at least, the mode of production is exceedingly unique, and so far as the writer is aware, is not mentioned in the surgical literature of the past ten years.

A careful search of the latter from 1905 through 1915, on the part of Miss Frances K. Ray, New York State Medical Librarian, and her assistant, Miss Cady, has failed to reveal a single instance of a case report such as herewith presented.\*

Dr. Lewis A. Stimson, in a personal communication to the writer, has kindly furnished a reference to a case published by Ebermayer.<sup>3</sup> The latter in a painstaking and scientific article entitled "Über (isolierte) Verletzungen der Handwurzelknochen," presents a series of cases with röntgenographic reproductions, among which is shown a fracture of the trapezium associated with fracture of the first metacarpal.

The mode of production of the fracture is not given, and the association of fractured metacarpal places the lesion somewhat foreign to the type of fracture we are presenting. The article itself, however, is probably one of the best general expositions of carpal fractures that has been published since the classic contribution of Codman and Chase.<sup>4</sup>

The most recent case report with röntgenographic findings is one that has come to the writer's attention during the preparation of this

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\* The production of the fracture through the mechanism of forcible internal rotation unaccompanied by any direct violence.

## REDUPLICATION OF THE URETER

reports indicate. As for the skilled cystoscopist whose eye at once detects any vesical abnormality even of pin-point size, an aberrant ureter with bladder orifice will rarely escape observation *if he look for it*. But for those who only now and then catheterize ureters, a third orifice will easily and generally pass unnoticed even after repeated examinations. The chief reason for this is that having found and catheterized two ureters, the inspection at once halts, the possibility of a third never having entered one's mind. It is this point particularly that we wish to emphasize. We now invariably exclude the presence of abnormal ureters in the course of routine cystoscopy. If this plan were adopted universally we believe many more reduplications would be discovered and many more obscure cases cleared up.

The surgical significance of the anomaly is quickly apparent and is well exemplified in our cases. As stated at the outset, we limit our discussion to the supernumerary ureters with vesical outlet. If the orifice is situated elsewhere the clinical picture and the therapeutic considerations are entirely different: these cases fortunately are rare.

Any anomaly to some degree alters the normal physiology of the body and invites pathology. In the case of a kidney with two pelves and ureters one of them is more than likely to be of rudimentary size and function and peculiarly liable to disease. Infections in such pelves are common. Three of our cases illustrate this, the normal pelvis remaining unaffected. If the third ureter is not eventually discovered, primary catheterization of the other two may lead to exclusion of the urinary tract from further consideration, while the patient is hopelessly treated in some other direction. Should the condition progress to an involvement of the renal parenchyma, knowledge of the third ureter may open the way for a conservative surgical attack, the diseased portion of the organ being removed with its pelvis and the other half retained. Stone in the third pelvis or ureter may cause no end of confusion if only the other two ureters are catheterized. Various other considerations might be offered but they are easy to project for one's self. We call attention to only one; it is evident after a review of the history that the right-sided pain for which our Case III had such a variety of treatment was, in fact, of renal origin, and was due to stasis and distention of a rudimentary third pelvis, due to partial stenosis in a rudimentary third ureter. Furthermore, the history compels the belief that relief from pain was directly due to the relief from stenosis by means of the dilating ureteral catheter. We therefore feel that this case not only represents an anomaly, but properly comes within another group, the outstanding feature of which has been a ureter stenotic in greater or lesser degree. These will be considered in detail in a subsequent report.



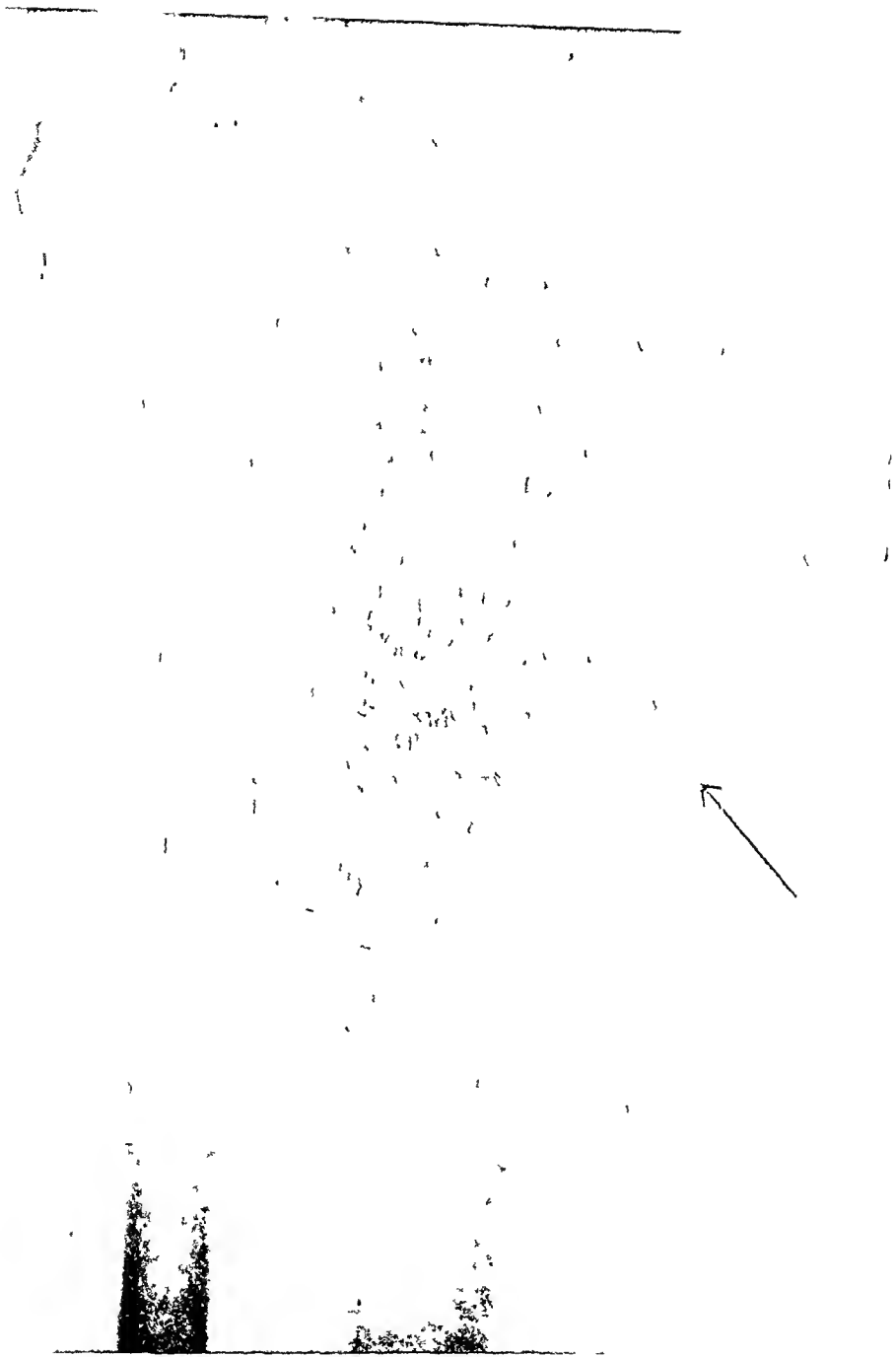


FIG. 1.—Isolated sprain-fracture of trapezium from indirect violence

work, and beyond a slight muscular weakness the condition is normal.

Although the publication of a case report such as the above is interesting rather from a casuistic standpoint than from the practical surgical aspect, nevertheless, the relative rarity of the fracture coupled with the unusual mode of production is worthy of note. There is no question that the term "sprain," particularly as applied to ankle and wrist, covers a multitude of diagnostic errors, based not so much upon lack of personal skill as upon the unwillingness of many to utilize the Röntgen ray in their own work, or to refer cases of this description to the proper individuals, provided they themselves do not feel qualified to act as surgeons. This is not only true in a large degree as respects ankle and wrist but will hold good for a variety of lesions in which the use of röntgenograms for the determination of bone and joint involvement is indicated, as has been pointed out in a previous communication.<sup>6</sup> The surgeon is brought in contact time and again with cases originally diagnosed as "sprain," "strain," etc., which in reality, as proven by röntgenogram, are fractures and sometimes dislocations.

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- <sup>2</sup> Preston: Fractures and Dislocations.
- <sup>3</sup> Ebermayer: Fortschritte auf. d. Gebiete der Röntgenstrahlen, vol. xii.
- <sup>4</sup> Codman and Chase: ANNALS OF SURGERY, May, 1905.
- <sup>5</sup> Perkins: Medical Record, September 23, 1916.
- <sup>6</sup> Bendell: Albany Medical Annals. March, 1914.

## SPRAIN-FRACTURE OF TRAPEZIUM

article. It is a case reported by Perkins,<sup>5</sup> showing a fracture of the outer end of the trapezium produced by a fall on the outstretched thumb and hand, the symptoms consisting of pain and swelling at the base of the thumb. Diagnosis of the condition was established only through the use of the röntgenogram.

From the above it is apparent that although the lesion in question may occur, nevertheless the literature is almost barren, at least for the past ten years, of reported cases.

Doubtless as in many other types of fracture long regarded as unusual and rare, the use of the Röntgen ray is showing the fallacy of regarding certain of these lesions as uncommon, and the case herewith reported may fall within this latter group, although the facts hardly warrant such an assertion.

Our case in question is as follows:

Mrs. A. N., aged forty-eight, seen on August 15, 1916, complaining of painful swollen wrist. On August 10, the patient, while turning the knob of a door with her right hand, gave the latter a sudden unexpected twist. She experienced a sharp pain in the wrist and noted that movement of the joint was accompanied by discomfort.

Within a few hours the wrist became swollen, the œdema extending along the hand and involving the fingers, so that movements of the latter were painful.

The patient was advised to use a liniment on the swollen parts, having been told by a physician that she was suffering from a "sprained" wrist. The œdema and pain became less, but a certain amount of disability and discomfort persisted. Upon examination there is noted œdema of the entire wrist, particularly of the dorsal surface, extending along the lower arm. Flexion and external rotation of the wrist produce a certain amount of pain, although there is discomfort when the wrist is moved in any direction.

No crepitus is obtainable and there is no apparent deformity, although the rather marked œdema over the dorsal aspect of the wrist is suggestive of a pseudo-silver-fork deformity. A röntgenogram taken by Dr. W. P. Howard, of the Albany Hospital, reveals a spicule of fractured trapezium (Fig. 1).

The hand and wrist were immobilized by means of a light plaster case, the fingers being left free. At the end of two weeks the case was removed and massage instituted. At this time the œdema had almost entirely disappeared and pain on motion was slight. At the present time (October, 1916) the patient is using her hand without any difficulty to perform the usual house

culty of obtaining a sufficient number of persons willing to part with the large area of skin necessary. Then there had to be taken into account the failures of graft to take that might be expected in treating vast second degree burns, some of which were ten inches in diameter.

While I had always believed from my long experience in artificially promoting tissue growth that burns could be successfully treated without skin grafting by supplying to the cells surviving on the wound's edges nourishment calculated to accelerate proliferation, the opportunity to try out my ideas found me not altogether prepared as to what cell food would produce most satisfactory results. Horse serum heretofore employed in hæmophilia neonatorum, hemorrhage from the umbilical cord, post-operative hemorrhage, etc., and as an application to the oozing surfaces of wounds, occurred to the mind as a possible resort. However, a search for information in current medical literature and inquiries at the Lederle Laboratory where this serum is obtained, afforded no light regarding its availability as a local application in cases of burns. So the experiment had to be made without supporting precedents.

The test of the horse serum was first made on the tenth day after admission to the hospital and several large burns of the second degree were selected. Two of these located on the buttocks were six to eight inches in width and about ten inches in length. Normal horse serum containing a small percentage of tricresol was sprayed on the marginal skin cells and the parts thus treated were covered with rubber tissue.

At this point it may not be out of place to mention that with tubes containing only enough serum for a single application, the tricresol acting as a preservative may be safely omitted from the preparation, thus preventing a certain amount of painful smarting during the spraying process and possibly accelerating cell proliferation.

The repetition of this treatment several times a day for ten days resulted in a complete recovery without complications, such as the formation of pus or of proud flesh. The marginal cells thus threw out new cells, not condemned to die of starvation in the devitalized areas, but nurtured by the plasma obtained from animal blood. Instead of requiring four or five months of treatment, as is usual in grafting operations, the patient was discharged from the hospital twenty-one days after her admission.

Dr. Sinnott pronounced this the most rapid case of healing within his experience and declared his intention of hereafter using serum in the treatment of burns, thus avoiding the tortures and uncertainties of grafting operations.

## ARTIFICIAL CELL PROLIFERATION WITH HORSE SERUM IN THE TREATMENT OF BURNS

BY EDWARD PERCY ROBINSON, M.D.

OF NEW YORK

THE recent publication in the *British Medical Journal* of a contribution by Dr. R. J. Williams, regarding asepsis in the treatment of burns, suggests the timeliness of calling attention to what is as far as I know an original method of treatment at variance with that proposed by Dr. Williams, as well as with that practised by other physicians. It has for some time seemed to me that over emphasis has been given to asepsis, which may not only not assist but even retard natural processes of repair.

For some fourteen years the writer has been out of general practice and has been interested in special lines of work depending on the artificial stimulation of cell proliferation. His success in inducing growth of cellular tissue in cases of atrophy due to imperfect nutrition had long suggested the possibility of promoting through analogous processes the repair of tissues destroyed by burns due to fire, hot water or traumatism. In a practice limited to narrowly specialized lines no opportunity occurred for a practical application of the writer's notions until a recent accident to a relative presented a case with conditions difficult or even impossible of treatment by ordinary methods.

The patient, a woman forty-five years of age, severely scalded herself with boiling water. The injured surfaces were upper and middle third of right leg, from ten to twelve inches in length and four to eight inches in width, calves of both legs and ankle of left foot, deep burns on both buttocks and on left hip, superficial burns on right cheek. The surface area of devitalized skin exceeded one-third of the entire surface of the body. The burns were about equally of first and second degree in extent. Within a half hour of the accident the patient was taken to the hospital in Mt. Vernon, New York. First a temporary dressing of carron oil was applied and the patient placed under the care of Dr. J. J. Sinnott of the same city. On the following day the burns were dressed with an antiseptic ointment. An acute nephritis developed within twenty-four hours after the accident but rapidly subsided.

With so extensive a loss of skin, it was evidently impossible both to Dr. Sinnott and myself to bring about satisfactory epidermization through skin grafting, owing to the insurmountable diffi-



# TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

*Stated Meeting, held November 22, 1916.*

The President, DR. CHAS. N. DOWD, in the Chair

CENTRAL SARCOMA OF THE LOWER END OF THE FEMUR WITH EXTENSIVE INVOLVEMENT OF THE KNEE-JOINT SUCCESSFULLY TREATED WITH THE MIXED TOXINS OF ERYSIPELAS AND B. PRODIGIOSUS

DR. WILLIAM B. COLEY presented a woman (not previously reported) twenty-one years of age, who was first seen in consultation with Dr. V. P. Gibney, at the Hospital for Ruptured and Crippled, in October, 1914. Family history negative; Wassermann negative.

Eight months previously patient first noticed pain in the left knee, while walking up and down stairs. This gradually increased in severity and shortly after was present even while walking on level surfaces. She consulted a physician who applied Buck's extension to the knee, with slight temporary relief. A little later she entered a hospital where a plaster-of-Paris splint was applied, which she wore for five weeks. No improvement was noticed; thereupon several teeth were removed, on the ground that she was suffering from osteoarthritis due to pyorrhœa. Later on she was placed upon specific treatment. In spite of these widely varied therapeutic measures, the swelling and pain increased, and the patient was unable to bear the weight of her body upon the limb. She was admitted to the Hospital for Ruptured and Crippled (Dr. Gibney's service) on October 24, 1914, at which time physical examination showed general condition good; heart and lungs normal; patient wearing a plaster splint. There was marked swelling and infiltration of the whole lower end of the left thigh and anterior aspect of the left knee. The knee was completely extended, with very greatly increased abnormal lateral motion, showing destruction or extreme laxity of the tissues. There was marked infiltration of the popliteal space, and moderate atrophy of the limb.

*Measurements.*—Left, 15, 15½, 12; right, 14¼, 14, 12.

The X-ray showed very marked expansion of the lower extremity of the femur; cortical substance thin and apparently on the point of breaking through; structure of bone disappeared.

In view of the extensive involvement of the knee-joint accompanied with great tenderness and extreme mobility, after careful examination and study of the X-ray plates, Dr. Coley concluded that the disease

## HORSE SERUM IN THE TREATMENT OF BURNS

To conclude with a final reference to the contribution in the *British Medical Journal*, aside from differing with Dr. Williams as to the efficiency of asepsis without artificial aid in cell proliferation, the writer is also of the opinion that in the treatment of burns an error is made in puncturing the blisters. By opening the blebs and allowing the liquid to escape, the surgeon is interfering with nature's provision of a sterile serum protected by a covering of skin, than which no man can substitute a better dressing. In accordance with this belief, in the case under consideration, the blebs were left unpunctured with most satisfactory results.



FIG. 3.—Well two years and two months. Disappeared under toxins following exploratory operation.

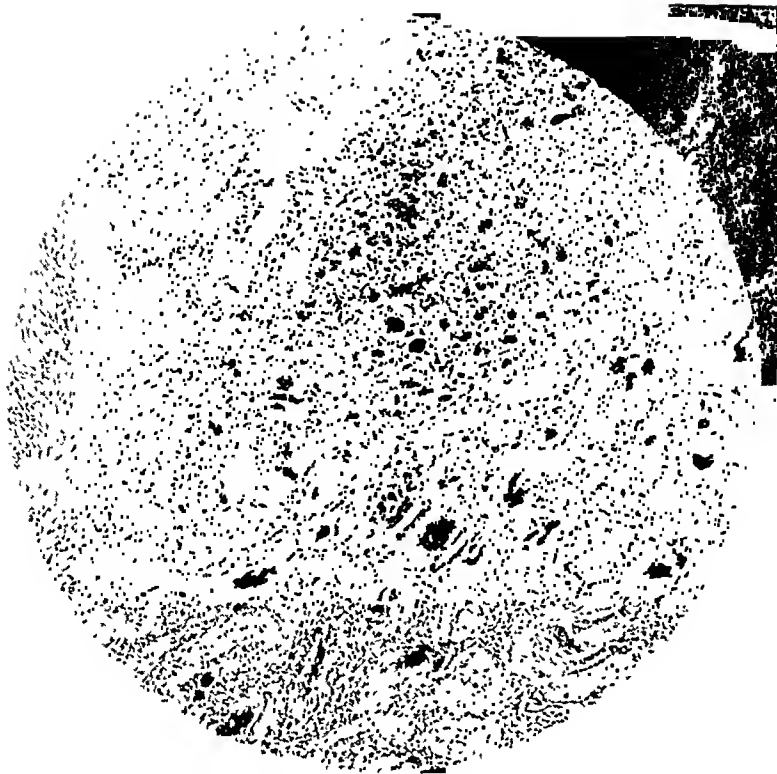


FIG. 1.—Very extensive sarcoma of femur involving knee-joint. Amputation refused. Recovery under toxin treatment after exploratory operation. Now well twenty-six months.

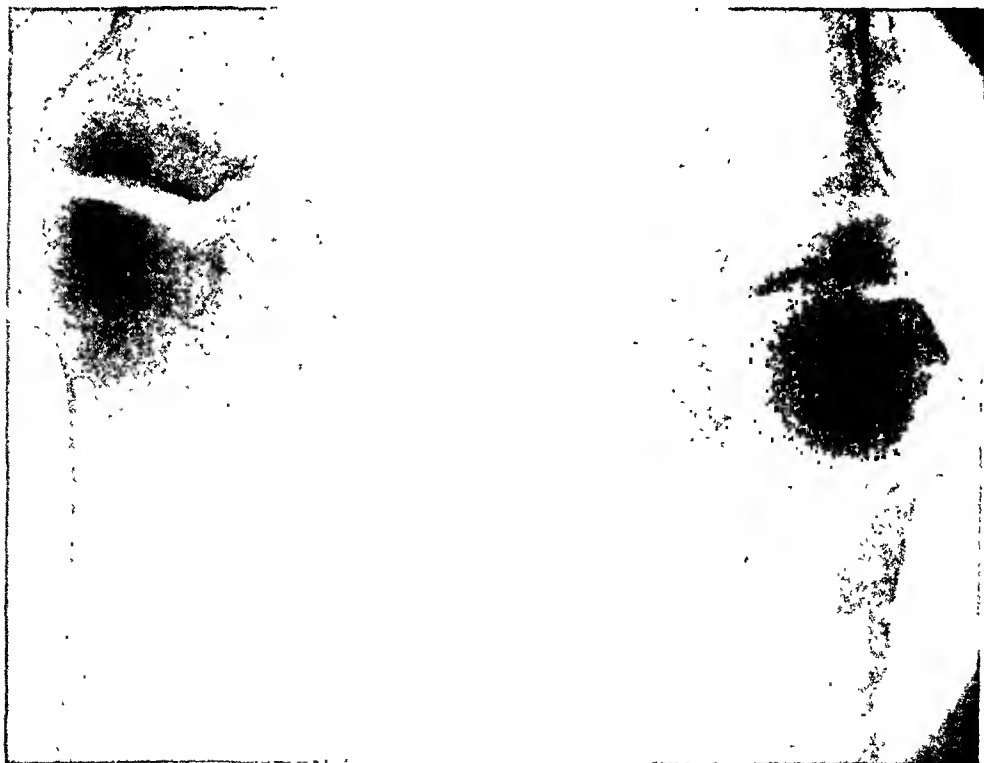


FIG. 2.—September 26, 1914. Sarcoma of femur involving knee-joint. Before treatment.

were begun on November 11, one minim, and increased daily by  $\frac{1}{2}$  minim, until December 27 when  $8\frac{1}{2}$  minims (the highest dose) was reached, which produced a temperature of  $104^{\circ}$ . After this, a short interval of one week's rest was given; the toxins were then resumed, and kept up for one year with occasional brief periods of rest, seventy-three injections in all being given.

On December 2, 1915, Dr. Gibney reported that there was no deformity; the limb was straight with little, if any, motion. Two days later, December 4, the patient was discharged from the Ruptured and Crippled Hospital, wearing a brace on the right leg.

Inasmuch as the sinus had failed to heal the patient was given an anæsthetic and through-and-through drainage was established; curettings carefully examined by Dr. Ewing failed to show any evidence of malignancy. Rubber tubes were inserted and kept in for a number of months.

Patient was readmitted to the Ruptured and Crippled Hospital on March 7, 1916, for infection of old sinus. Just before admission, she developed pain and slight fever. Examination revealed what was apparently an inflammatory enlargement of the knee with a boggy swelling of the popliteal region. These symptoms continued and later fluctuation developed. In March, under local anæsthesia, an incision was made in the popliteal opening and a small abscess was found which apparently communicated with the old sinuses. One of these was opened and curetted and both openings were drained. Examination of curettings again failed to show evidence of malignancy. She was shortly treated with "Dakin's fluid" and rapid healing followed. The toxin treatment was resumed for a brief period and the patient has remained in good health ever since, upwards of two years since beginning of treatment; has gained 35 pounds in weight.

NOTE.—She is in good health, March 1, 1917, and walks with a brace.

#### EXTENSIVE SARCOMA OF THE UPPER END OF THE TIBIA INVOLVING THE FIBULA: CONSERVATIVE TREATMENT (TOXINS AND RADIUM): LEG SAVED

DR. WILLIAM B. COLEY also presented a young woman, seventeen years of age, who was admitted to the Hospital for Ruptured and Crippled on July 22, 1915, with a history of having first noticed trouble in the upper part of the right leg, just below the knee-joint, six months prior to her admission. This consisted of a small swelling on the inner side of the upper portion of the right tibia, slight amount of pain, increasing disability, and moderate loss of weight; no enlargement of glands in the groin. At the time of her admission to the hospital she presented a symmetrical enlargement of the whole upper portion of the

## CENTRAL SARCOMA OF LOWER END OF FEMUR

was undoubtedly a central sarcoma which had pierced the cartilage of the joint, causing joint involvement and effusion. This condition is extremely rare and he had never, up to that time, seen a case similar to it with such extensive joint involvement. Dr. Gibney and Dr. Whitman also believed the condition to be sarcoma. They considered it too far advanced to justify conservative treatment, and strongly urged immediate amputation. This, however, was refused by the patient and her family. On November 6, 1914, an exploratory operation was made to obtain a piece for microscopic examination. On cutting down to the periosteum, a mass was found which occupied the entire lower end of the femur, the central portion of which was greatly expanded and occupied by a tumor having the typical clinical appearance of a sarcoma. It was quite vascular and penetrated into the joint; there was considerable effusion in the joint. As much of the tumor as possible was curetted out and the wound packed. Hemorrhage, which was severe, was fairly well controlled with tight packing, and the limb was put in a plaster-of-Paris splint. After microscopical examination Dr. F. M. Jeffries reported it as a "mixed-celled sarcoma."

A further examination was made by Dr. J. Ewing, who reported as follows:

The material consists of several broken portions of tumor tissue, each about 1 cm. in diameter.

On section the masses are composed of dense fibrous tissue, in many places hyaline, covered with a fringe of sarcomatous tissue of the type of giant-cell sarcoma. The giant-cells are of the epulis type. There are a few trabeculae of bone which are separated by spindle tumor cells and are undergoing absorption. In several places the dense fibrous tissue is infiltrated by strands of tumor tissue in which the cells are spindle in form, with slightly hyperchromatic nuclei, but without admixture of giant-cells.

In the absence of full data regarding the anatomy of the tumor and its clinical course, it is impossible to give any positive opinion of the clinical malignancy of the case. The giant-cell areas belong in a group which generally pursue a benign course. The spindle-cell areas seem to possess greater growth capacity.

X-ray examination, November 11, 1914, showed an attempt at formation of a new joint; shaft of femur resting on the outer articular surface of the tibia. Over the inner articular, to correspond with the inner condyle, is new bone formation, making a contour of a fairly good joint; no ankylosis between femur and tibia. Lateral view shows new bone formation, anterior to the patella; appears to be some ankylosis with the patella; no evidence of metastasis.

A few days after the exploratory operation the patient was put upon the mixed toxins of erysipelas and bacillus prodigiosus, and the doses were carried up to the point of giving a severe reaction. The toxins

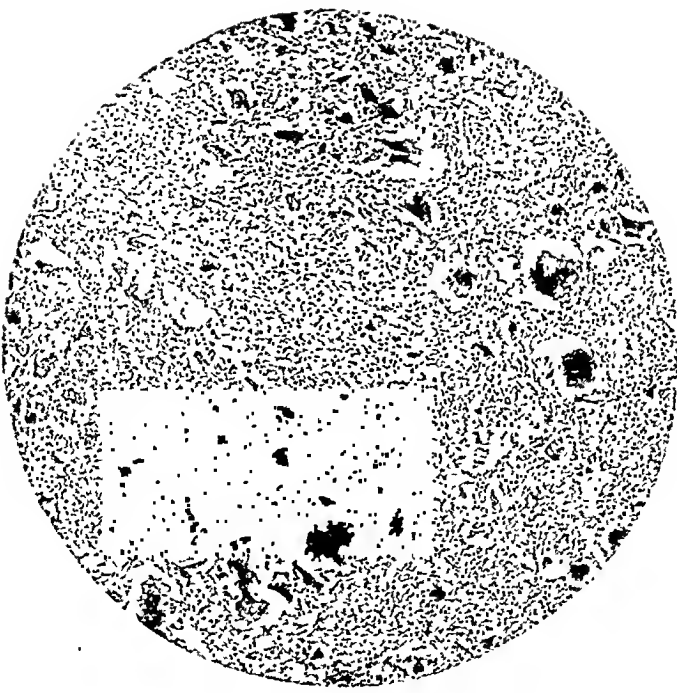


FIG. 6.—Fibrosarcoma of tibia, containing numerous giant scavenger (foreign body) cells. (Photomicrograph x80, Barrie.)

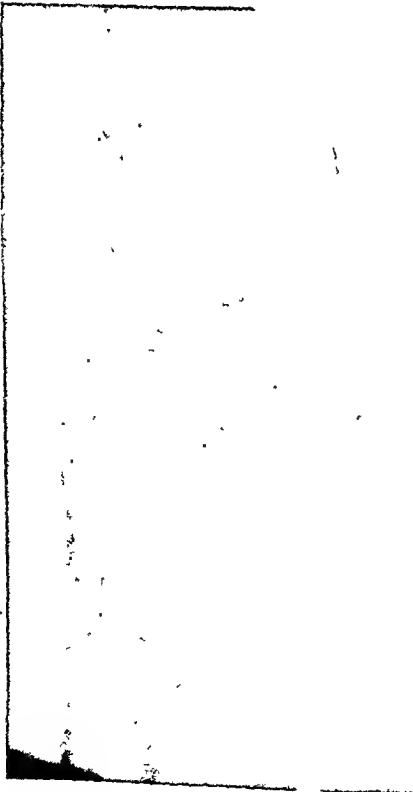


FIG. 7.—July 23, 1915. Before treatment.



FIG. 8.—July 23, 1915. Before treatment.

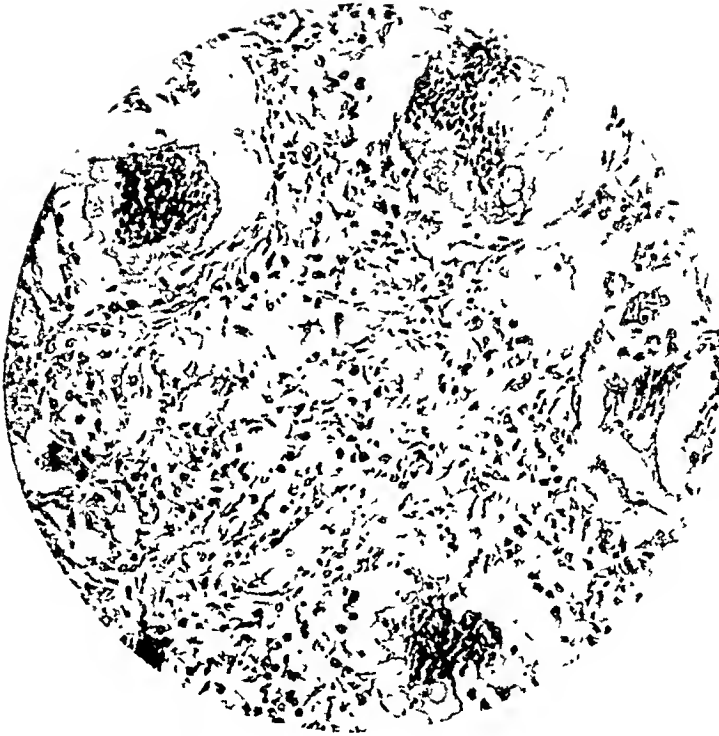


FIG. 4 —Fibrosarcoma of tibia containing giant scavenger (foreign body) cells. (Photomicrograph, high power, Barrie.)

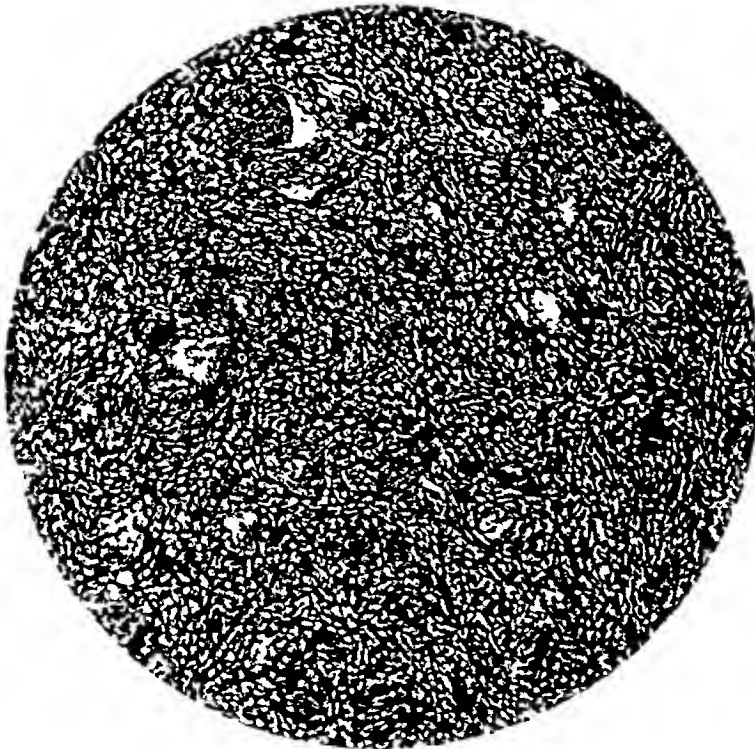


FIG. 5.—Central sarcoma of tibia, giant-celled (epulis type). Recovery under toxin treatment. Well one year. (Ewing.)







FIG. 9.—November 2, 1916. One and one-half years after treatment. Plaster cast obscures outline.

motion allowed, not fully tested. General condition excellent. On high road to recovery."

The leg and thigh were kept in a plaster splint and the sinus treated through a window in the splint. By December 1, the sinus had closed and there was no evidence of any tumor either by physical or X-ray examination. X-ray pictures were taken regularly every two weeks. Marked new formation of bone could be noticed in the upper end of the tibia, which was completely destroyed at the time of operation. The patient also gained in weight and strength. On December 27, 1915, she was shown before the Alumni Association of the Hospital for Ruptured and Crippled, at which time there was no evidence of any lesion present.

On January 9, 1916, the patient suffered from an attack of grippe and the toxin treatment was discontinued for two weeks. On January 26, the plaster case was removed and a recurrent tumor the size of a pullet's egg was found at the upper and inner end of the right tibia, at the site of the old sinus. An X-ray picture also showed the growth. The toxin treatment was again administered, and given both locally and systemically. The tumor diminished somewhat in size but did not disappear, and on March 3, 1916, a portion of the growth about the size of a hen's egg was removed by curette and the wound was packed. A microscopical examination of the mass removed was made by Dr. Ewing, who pronounced it "giant-cell sarcoma." Blood examination, March 5, 1916: Red blood-cells, 4,856,000; white blood-cells, 7,800; hæmoglobin, 82 per cent.

On March 10, 100 mg. of radium emanations were applied over the site of the tumor, and allowed to remain for twenty-three hours. The toxin treatment also was resumed, the doses being increased every other day up to the point of producing a temperature of  $102^{\circ}$ – $103^{\circ}$ . The soft tumor-like area slowly increased in size, and by April 1 it measured 1 by  $\frac{3}{4}$  inch; it was non-fluctuating. On April 8, 150 mg. of radium emanations were applied to the lower and ulcerated portion of the swelling, and kept on for seven hours, after which it was moved two inches higher over the articular surface of the tibia. On July 22, 240 mg. of radium were applied over the same site, for fourteen hours. Her local condition continued to improve, the sinus gradually healed, and the patient's general condition returned to normal. The toxins were continued during the summer with occasional intervals of rest.

On October 4, 1916, when she left the hospital, there was no sign of a tumor and she was in good physical condition.

At present, November 22, 1916, there are no signs of local or general recurrence, and she has gained twenty-four pounds in weight.

NOTE.—She remains well March 1, 1917, and is walking with a brace.

## EXTENSIVE SARCOMA OF UPPER END OF TIBIA

right leg, most marked below the patella. The limb could be flexed to about a right angle; no muscular spasm. Over the inner portion, the tumor was extremely soft on palpation, having the "feel" of semi-fluctuation.

*Measurements.*—Right,  $11\frac{1}{2}$ , 12,  $12\frac{3}{4}$ ,  $11\frac{3}{4}$ ; left,  $11\frac{1}{2}$ ,  $11\frac{5}{8}$ ,  $11\frac{1}{2}$ ,  $10\frac{3}{4}$ .

X-ray showed a tumor involving the entire upper extremity of the tibia, the bony structure of which was practically destroyed except on the outer and upper aspect; other bones not affected. The disease was so extensive that amputation was strongly advised, but refused by the patient. In view of the successful results obtained with the toxins in the case of sarcoma detailed above, conservative treatment was advised in the present case, *i.e.*, curetting for a microscopical section, to be followed by toxin treatment. In this opinion Dr. Gibney concurred.

On August 2, 1915, a four-inch vertical incision was made below the knee. The tumor was curetted out, and found to involve the whole upper part of the tibia for a distance of four inches, and nearly the same length of fibula, with the exception of the outer wall; a thin layer of cartilage which was perforated in curetting was all that was left of the upper end of tibia. The wound was packed with gauze, and a roller bandage tightly applied and the limb put up in plaster of Paris before removing the tourniquet. Pathological examination was made by Dr. F. M. Jeffries (pathologist to Hospital for Ruptured and Crippled), who reported the tumor to be "giant-celled sarcoma—melanotic."

Dr. James Ewing also examined a section microscopically and reported: "Tissue is composed of typical giant-cell sarcoma of epulis type and of very moderate malignancy."

A third examination was made by Dr. George Barrie, of the Post-Graduate Hospital, who pronounced it "fibrosarcoma with giant-cells." The clinical history of rapid development and extensive involvement furnish sufficient evidence of the malignant nature of the tumor. Blood examination, August 10, 1915; red blood-cells, 4,700,000; hæmoglobin, 85 per cent.

Four days after curetting, the patient was put upon small doses of the mixed toxins of erysipelas and bacillus prodigiosus (no other treatment). The initial dose,  $\frac{1}{2}$  minim, was increased daily, by  $\frac{1}{2}$  minim, until a decided reaction temperature of  $102^{\circ}$ - $103^{\circ}$ - $104^{\circ}$  was obtained, after which, four injections a week were given.

The cavity gradually filled up with healthy granulations, and a note by Dr. V. P. Gibney, dated November 15, 1915, states: "Open sinus over inner head of tibia; no infiltration about knee. Small range of

## CALCAREOUS PLAQUES IN THE ABDOMINAL AORTA CAUSING A STENOSIS OF THE PYLORUS

DR. H. H. M. LYLE presented a man, aged forty-five years, who entered the St. Luke's Surgical Service October 27, 1916, having suffered from stomach trouble for fifteen years. He gave a typical history of pyloric stenosis, dilated stomach, and motor insufficiency. Chemical examination of stomach contents: Total acidity 46, free acidity 14, combined 18, no blood. Wassermann negative. Red blood-cells 5,000,000; hæmoglobin 95 per cent. The radiological findings showed a high grade of pyloric stenosis with a corresponding dilatation of the stomach. The abdominal examination revealed in the epigastrium, just to the right of the spinal column, a hard fusiform pulsating tumor. Its long axis was vertical, there was no movement with respiration, but the tumor could be moved slightly from side to side.

On the evening previous to the admission of the patient to the hospital, Dr. Lyle had heard Dr. Eliot, of the Society, report a case of "plaques" in the portal vein mistaken for a gall-bladder full of stones. With this fresh in mind the patient was sent to the operating room with the tentative diagnosis of dilatation of the stomach, pyloric stenosis, abdominal aortitis. On opening the abdomen the stomach was found to descend into the pelvis, the pylorus was represented by a fine tube four inches long and less than the diameter of a lead pencil. There were no signs of ulcer, the extended pyloric tube being perfectly soft. There were no adhesions or enlarged glands. The gall-bladder was normal. The thickened calcareous aorta lay to the right of the spinal column, and passing over it was the extended pyloric tube. A non-loop gastro-enterostomy was performed. The patient made an uneventful recovery.

Dr. Lyle said he was at a loss to explain the tube-like pylorus, because, although the lumen of the tube was very small, it was soft and supple and showed no evidences of connective-tissue changes. In this case the lesser curvature near the pylorus was fixed well up in the abdomen, while the greater curvature was in the pelvis. Could the stretching of the dilated stomach across the rigid aorta have caused the condition?

## HOUR-GLASS DEFORMITY OF STOMACH

DR. FREDERIC T. VAN BUREN presented a woman, aged forty-three years, who entered Roosevelt Hospital on Dr. Dowd's service, April 9, 1916, suffering from symptoms pointing to perforation of a gastric ulcer, with an onset three days previous to admission.

Immediate operation under ether anæsthesia disclosed a perforation of the pylorus about  $\frac{1}{2}$  cm. in diameter with firm adhesions binding together the gall-bladder, stomach, duodenum, transverse colon and

## SARCOMA OF THE LONG BONES

### CONSERVATIVE TREATMENT OF SARCOMA OF THE LONG BONES

DR. COLEY also presented four other patients who had recovered from sarcoma of the long bones under conservative treatment.

The first case dated from January, 1910—a very rapidly-growing spindle- and round-celled sarcoma of the humerus with extensive involvement of the shaft. Patient, a man, was referred by Dr. Finney, of Baltimore, as an inoperable case. Toxins given for six months (no other treatment); apparent complete disappearance of tumor, reunion of bone. Recurrence a few months later near the shoulder; amputation. Several months later a large mass appeared in the pectoral region beneath the muscle, the size of two fists; incomplete removal followed by toxins for long period. Complete recovery; patient shown at meeting.

Dr. Coley said that his case would be remarkable no matter what type of growth it presented, since, as far as he had been able to ascertain, there has been no sarcoma of the humerus that had recovered and remained well for a period of three years after amputation or any other method of treatment. Several pathologists, including Dr. Bloodgood and Dr. Ewing, examined the tumor in this case, and all pronounced it of highly malignant type; spindle- and round-celled, no giant-cells.

The speaker also referred to the case reported by Dr. J. Bapst Blake of Boston, of sarcoma of the upper end of the humerus with involvement of the scapula, which after an incomplete operation (curetting) recovered under prolonged toxin treatment, and was in good health twelve years afterwards.

Dr. J. H. Gibbon, of Philadelphia, also reported a case of periosteal round-celled sarcoma of the humerus, in which, the patient having refused amputation, Coley's toxins and the X-ray were resorted to, with the result that the tumor completely disappeared, and the patient was in good health six years later. (Two additional cases of sarcoma of humerus have been successfully treated with the toxins, and arms saved.)

DR. COLEY presented also three other patients. One, a woman, twenty-seven years of age, with periosteal sarcoma of the femur, who had recovered under the mixed toxin treatment and had remained well for four years; the second, a woman, seventeen years of age, with a myeloid sarcoma of the lower end of the tibia, who had recovered under the toxin treatment and had remained well for eleven years; in this case X-rays were used in conjunction with the toxins; the third, also a woman, twenty-six years of age, who had a giant-celled central sarcoma of the radius, and after curetting had been subjected to the toxin treatment and had remained well for eight and one-half years.

These had been reported by him in his earlier reports on the subject and were now presented to show the final results.

isthmus about 3 cm. in width and length. This narrowed portion of the stomach presented no appearance of cicatrization or thickening to sight or touch, but persisted in size and shape while under inspection and apparently was a real deformity and not a spasm. Under the present condition of the parts a double posterior gastro-enterostomy was believed to be more feasible than a combination of gastrogastrostomy with gastro-enterostomy, and the former operation was done, uniting the jejunum as near as possible to the duodenojejunal angle, with the cardiac pouch; and uniting the pyloric pouch with the jejunum about two inches lower down. Both anastomoses were made through the same opening in the transverse mesocolon and chromic catgut was employed for the mucous suture and Pagenstecher for the seromuscular suture. The mesocolon was stitched to the borders of the anastomoses by several interrupted catgut sutures. The abdominal wound was closed in layers without drainage, and the patient made an uncomplicated recovery, leaving the hospital August 20, 5 weeks after second operation.

A skiagraph taken November 17, 1916, three months after her second operation, shows rapid emptying of the stomach, both cardiac and pyloric pouches, through the gastro-enterostomy openings. She has no symptoms of indigestion, and eats anything she pleases, only taking care to avoid known indigestible foods.

DR. W. S. SCHLEY said that in hour-glass stomach the tendency to recurrence after plastic operation is very great, even after some years have elapsed. Organization of exudate and plastic adhesion after inflammation or operation, with resulting contraction, seems particularly prone to occur with the stomach and upper duodenum although the process is often a very slow one. Two years is a little bit short for final judgment. He had shown one or two cases some time ago before this Society that recurred after a period of five years, after apparently complete restoration of the stomach contour in every particular. He was surprised to find a complete recurrence after five years, the patient having had excellent health and forty-five pounds gain in weight.

He believed that gastro-enterostomy should be a part of practically all operations for hour-glass contracture of the stomach of severe degree, and that operations that do not contemplate its inclusion in the reparative work for this condition are incomplete in certainly 75 per cent. of cases.

DR. CHARLES H. PECK said that some of the best results he had had in cases of hour-glass stomach had been with a plastic operation of the type of Finney's pyloroplasty. It is especially suited to cases where both cardiac and pyloric pouches are of fair size and the line of the lesser curvature is nearly normal. Dr. Kammerer first suggested this

## HOUR-GLASS DEFORMITY OF STOMACH

omentum. These adhesions walled off from the general peritoneal cavity an abscess containing about three ounces of pus with a colon bacillus odor. In separating the adhesions to mobilize the pylorus for purposes of repair, the right lumbar gutter was exposed and found to be partially filled with cloudy fluid. The perforation was repaired by a purse-string suture of plain catgut, reinforced by three interrupted transverse sutures, drawing the anterior wall of duodenum and pylorus together, and further defended by suturing fat tabs from the greater and lesser omenta together across the duodenopyloric junction. The wound was closed by layer sutures without drainage. Her recovery was complicated by infection of the superficial part of the wound. Healing took place by granulation, and she left the hospital on May 23, 1916, six weeks after operation, with a healed wound and no sign of hernia. Her health improved and she was very comfortable for ten weeks after the operation. Then she began to have a feeling of fulness in the upper abdomen and considerable eructations of gas and passed much flatus which relieved her. This distress came on in the evenings and she would feel pretty well in the mornings. Ten days before her second admission to the hospital, she vomited in the late afternoon, something she had eaten early that morning. A week later she vomited again. The vomitus was sour and bitter, but no blood was noticed in the vomitus, and no tarry stools were passed.

On July 11, three months after first operation, she entered Roosevelt Hospital on the service of Dr. Hotchkiss. At that time skiagraph of the stomach (which could not be taken before her first operation) showed what appeared to be an hour-glass deformity of the stomach with retention of bismuth in the pyloric pouch, after six hours, but no retention in the cardiac pouch. The deformity had not been suspected at the first operation and no effort had been made, at that time, to inspect the entire organ for fear of spreading the contents of the abscess around the perforation. With the evidence of retention and the skiagraphic appearances, a diagnosis of hour-glass stomach with pyloric obstruction by adhesions was made, and operation performed on July 13.

An incision mesial to the scar of the first was made through the upper right rectus, and adhesions between the viscera and the anterior wall separated with great difficulty, sufficiently to show the gall-bladder firmly adherent to omentum and transverse colon, across the duodenum. At this time only the pyloric portion of the stomach was visible, and very firm, broad and vascular adhesions between the stomach and under surface of the liver had to be separated before the cardiac portion of the stomach could be brought into view. Then it was evident that a cardiac and pyloric pouch, each of ample size, were separated by an



In the case that Dr. Fisk has presented there was a line of fracture on the right side of the mandible between the lateral incisor and canine, and on the left side posterior to the second molar (Figs. 10 and 11). A non-erupted impacted third molar is shown by the radiograph in this line of fracture. This tooth was extracted before complete reduction of the fracture could be obtained. This splint is easily made.

He saw the patient at noon. First he made impressions of the two jaws, and from these plaster models were made (Figs. 12 and 13).

The model of the lower teeth showed the displacement of more than the width of a tooth between the right lateral incisor and canine. This model was sawed through at this point and corrected to the original condition, using the upper model as a guide to the correct occlusion of the teeth.

Orthodontia clamp bands were then fitted to the first molars on each model and the arch wires adjusted accurately to the necks of the teeth. The bands were then clamped to the patient's teeth; the arches adjusted—gradually bringing the bone into position. The jaws were then immobilized by wiring the arch wires together (Figs. 13 and 14).

Sufficient liquid nourishment can be drawn between the teeth and behind the posterior teeth, or the mouth can be opened slightly by fitting a piece of rubber between the molars, on each side, before wiring.

Where there are no complications the appliance is worn four to six weeks.

DR. NATHANIEL GREEN said that some six or seven years ago he had quite a number of fractured jaws to treat at the City Hospital. At that time he took impressions of them and made tin splints cast from block tin, and then screwed them to the teeth with little screws like a watch-maker's. But they spread the teeth apart. He did not get a very good approximation of the fragments; but it helped materially with these cases. The trouble with that method was that it took about two days to make the whole thing. This splint of Dr. Vaughan's is very quick to apply and very neat, and it does what his did not do after it was put on—it puts a sort of turnbuckle on the whole jaw and brings the fragments close together instead of simply holding them—it squeezes them close together.

DR. EDWARD M. FOOTE said that the patient shown had excellent teeth in both jaws. Experience gained at the City Hospital where fractures of the lower jaw are common, convinced him that it is a most important thing for the patient to have good teeth. If both sets of teeth are intact, it is rare that a bad result follows fracture. The apparatus shown is very neat, and will undoubtedly shorten the period of recovery. But the

## COMPOUND FRACTURE OF THE LOWER JAW

procedure for hour-glass stomach and he first saw it used by Dr. Dowd. He had followed two of these cases for nearly three years and the result has been satisfactory, both have gained weight and have been free from obstructive symptoms. In cases in which the pouches are nearly equal and of good size, he believed this operation to be an excellent one.

DR. FREDERIC KAMMERER said that in one instance in which he had applied the Finney method for relieving an hour-glass constricture, the results were very good for six years, but had to be operated on after that time by another surgeon for a recurrence.

## COMPOUND FRACTURE OF THE LOWER JAW

DR. ARTHUR L. FISK presented a man who on Wednesday, November 8, sustained a double compound fracture of the lower jaw. One fracture was between the canine and second incisor teeth on the right side, this ran downward and inward towards the symphysis; and the other was between the second and third molar teeth on the left side, this fracture ran downward and backward towards the angle of the jaw. Both fractures extended completely through the body of the bone and both were compounded into the mouth. The fragment of the jaw between the two fractures was displaced downward and outward. The patient came to him November 9, sixteen hours after the injury—his pain was intense; he was unable to articulate easily or well, or to swallow; the mouth was open, from which saliva was running and the jaw was supported by his hands. He referred the case to Dr. H. S. Vaughan, who used a method and splint, which he has devised, that so perfectly reduced the fracture and held the fragments so well together after reduction that relief was immediate. There has not been any infection, infiltration of the tissues or abscess formation, so that the wounds have practically healed by first intention. These results are so unusual and the method in such contrast to all former treatments of fractures of the jaw, that at his request Dr. Vaughan had come this evening, to demonstrate this method to the Society.

DR. HAROLD S. VAUGHAN said that as all fractures of the mandible or inferior maxilla are compound and subject to mouth infection, when the line of fracture is in relation to the teeth, early and positive immobilization is necessary to prevent infected saliva from being sucked into the line of fracture, which results in an osteomyelitis with prolonged suppuration before final union is obtained.

During the past eight years he had made use of the orthodontia clamp bands fitted to the molars or bicuspid on each side of the maxilla and mandible, connected with an arch wire ligated to all the anterior teeth. The two jaws are then immobilized by wiring together the larger arch wires.



FIG. 12.—Shows model of lower teeth before correction. Note wide separation right lateral incisor and canine.



FIG. 13.—Shows models of both jaws with splint in position, after correction of lower model and adjustment to upper.

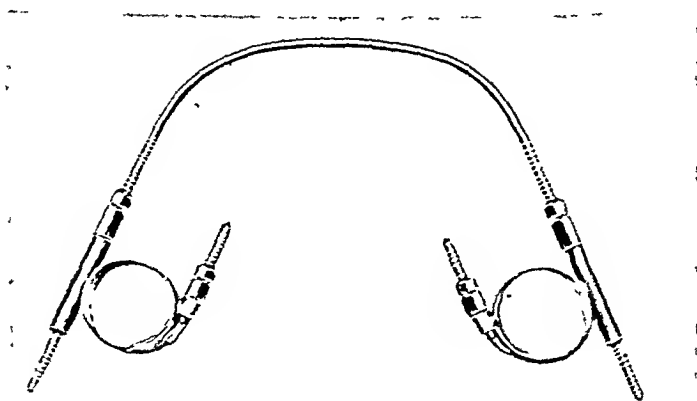


FIG. 14.—Shows adjustable clamp bands with tubes to receive the arch wires.

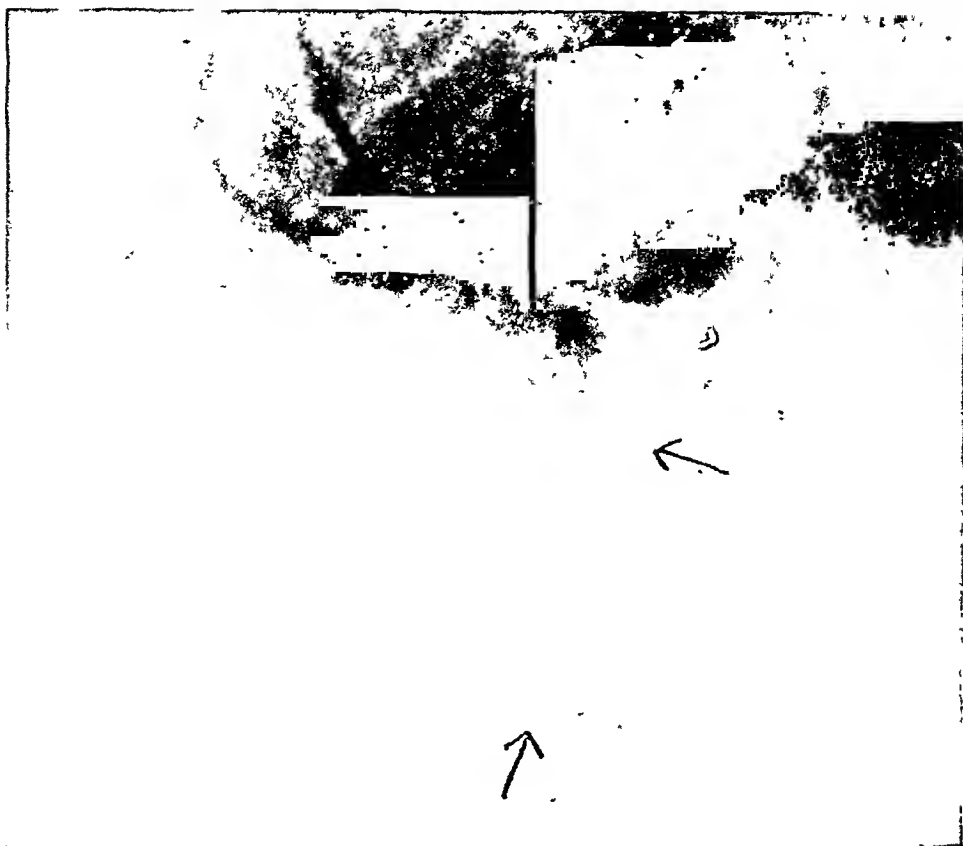


FIG. 10.—Shows fracture behind left second molar with impacted non-erupted third molar in the line of fracture.



FIG. 11.—Shows line of fracture between right canine and lateral incisor after adjustment of splint.

be distinct and freely movable and there was no evidence of mastitis. One similar mass was found in the right breast below and to the right of the nipple. This was also hard, smooth, round and freely movable.

Operation under ether anæsthesia by means of Thomas plastic method. Each breast was turned over and the tumors were removed through the posterior surface of the breast. The masses were found to be distinctly encapsulated, and each one could be easily enucleated. The microscopic examination showed these tumors to be adenofibromata. A small piece of one breast was removed and examined, and showed no evidence of chronic cystic mastitis.

Dr. Syms showed this case because it illustrated the fact that these are true tumors in the sense that they are not part of a cystic mastitis; they are isolated and encapsulated, and can be thoroughly enucleated. Dr. Syms emphasized the fact that these true adenofibromata should be removed by the plastic operation; the chronic cystic mastitis cases requiring, in his opinion, an entirely different method of treatment.

#### CHRONIC CYSTIC MASTITIS

DR. PARKER SYMS presented a woman, aged fifty-six years, who was admitted to Lebanon Hospital November 14, 1916.

Five months ago (July, 1916), the patient noticed a small lump in her right breast. She also complained of some tenderness or pain in her right breast. The pain was transient, and only present when the patient was fatigued.

*Examination.*—There is a hard, irregular, not freely movable mass near the nipple of each breast. There is not much irregularity or evidence of change in the texture of other regions of the breast; the process seems fairly localized. These masses are very different from the adenofibromata of the patient just presented.

*Clinical Diagnosis.*—Chronic cystic mastitis with tumor-like masses.

Dr. Syms presents this patient because he feels that it illustrates some facts brought out in the paper he recently read before the Surgical Society on chronic cystic mastitis. At that time he pointed out the fact that these masses, the so-called tumors—the adenofibromata of chronic cystic mastitis, are not true tumors; they are not separate and distinct; they cannot be enucleated but can only be removed by cutting through breast tissue. They are not suitable for the plastic operation of Thomas.

#### PERINEAL PROSTATECTOMY FOR PROSTATIC HYPERTROPHY

DR. PARKER SYMS presented a man, aged sixty-three years, who was admitted to Lebanon Hospital, November 9, 1916. One year had acute retention of urine; had to be catheterized. Since that time has been

## ADENOFIBROMATA OF BOTH BREASTS

difficult cases are those in which the teeth are faulty or do not match. These are the ones to put any treatment to the test.

DR. ARTHUR L. FISK said that in this patient the teeth did not match well to begin with, so that at the outset the case was not easy. Further, the fracture between the second and the third molar teeth made an additional complication which necessitated the extraction of the third molar tooth. The application of the splint gave almost immediate relief of the pain, because it held the fragments so accurately and firmly in position.

When the man first came to see him, he was a pathetic object; suffering excruciating pain; unable to speak or to swallow; on the following morning, the change was remarkable. The man sat reading the morning paper; he greeted him with a smile; he said that he had had a good night's rest, and that he had had something to eat. A great transformation in less than twenty-four hours!

There had not been any foulness of the mouth, as usually occurs in these cases—the compound wounds have been clean, so that they have healed by first intention, because of the accurate and firm coaptation of the fragments: and there has been no infection of the soft tissues with the formation of abscesses.

The splint being wholly within the mouth is therefore completely out of sight; it causes little if any inconvenience and permits the patient to resume work in a short time.

It is the neatest and best apparatus for treatment of fractures of the jaw thus far devised.

## ISCHÆMIC CONTRACTION OF FOREARM

DR. ROYAL WHITMAN presented a child five years of age, illustrating the effect of treatment of typical ischæmic contraction. He said that the patient was one of several that he had hoped to show at the last meeting, and the only one in which the contraction had not been complicated by sloughing of the tissues of the forearm. The contraction followed the treatment of fracture of the right forearm in February, 1915. The treatment had been by the Jones method and practically perfect functional recovery had been attained.

## ADENOFIBROMATA OF BOTH BREASTS

DR. PARKER SYMS presented a woman, aged twenty-four years, who was admitted to Lebanon Hospital, October 27, 1916. Three years ago she first noticed a swelling in her left breast. This has increased in size from that of a pea to that of an egg; has had no pain or tenderness.

On examination several smooth, hard, movable masses were felt in the left breast in the upper quadrant. These masses appeared to

cedure as nerve suture has not proved itself justifiable until the wounds of soft parts have entirely healed, thereby giving the surgeon a sterile field in which to operate. Then and only then can one in the average obtain successful nerve anastomosis. That at least is his own observation and the opinion of various workers with whom he came in contact, such as Bourchardt at Berlin, who had on his service at the Virchow Hospital up to April, 1915, some 300 nerve lesions of which 40 had been operated.

As to operation after the wound has declared itself clean by healing solidly, it was the general opinion in Germany that the earlier the nerve lesion is investigated by a competent surgeon the better. There were those who believed that one should wait from four to six months for spontaneous recovery. However, if the surgeon finds at operation no lesion to repair, no harm is done by careful inspection of the nerves. If on investigation scar only is found it usually suffices to loosen the nerve from cicatrix and to pack it round about with transplant of subcutaneous fat against further constriction. In every case the electric conductivity of the nerve should be tested through the scar or through the traumatic neuroma so commonly produced in these injuries, and if area of non-conduction be found that portion of the nerve or neuroma should be excised and the nerve ends sutured. By this method a considerable portion of a nerve cylinder may be rescued intact from entangling scar or neuroma. It is a long tedious task involving technical knowledge and surgical nicety to work out one of these lesions.

DR. H. H. LYLE said that he wished to emphasize Dr. Fischer's statement of the seriousness of injury to a peripheral nerve. Damage to an important peripheral nerve is an injury of extreme gravity.

Dr. Fischer, in his paper, has given us an able presentation of the operative side of the question. Dr. Lyle said that he wished to call attention to the importance of the physiological treatment of such wounds. Unrelieved, overstretched muscular tissue leads to fatty degeneration and consequent loss of contractility, and it is imperative, whether the nerve is divided or not, that the paralyzed muscles be relaxed and protected from strain by a suitable apparatus. This postural prophylaxis begins with the reception of the wound and continues after the operation until voluntary motion is restored. A strict adherence to this vital orthopædic principle aids in the diagnosis, hastens recovery, prevents many deformities, and diminishes the number of useless limbs.

Dr. Lyle said that in his article, "The Physiological Treatment of Bullet and Shell Wounds of the Peripheral Nerve Trunks" (*Surgery, Gynecology and Obstetrics*, February, 1916, p. 127), he had said that primary nerve suture is rarely indicated in war time. This statement

## GUNSHOT WOUND OF THE PERIPHERAL NERVES

troubled with frequency of urination. At present he urinates every twenty or thirty minutes during the day and six or eight times at night.

The catheter can be passed with reasonable ease. Residual urine, ten ounces; urine clear and of fair specific gravity; prostate is found to be enlarged, two lateral lobes; it extends high up, doubtless projecting into the bladder.

*Operation* (November 15).—Perineal prostatectomy through median incision. The lobes were exposed to view and enucleated with little difficulty. November 17, the double drainage tube was removed; November 18, the patient has bladder control; November 19, patient urinates through urethra; November 22, patient holds his urine four to five hours; urinates freely through urethra.

Dr. Syms showed this patient to illustrate what can be accomplished by perineal prostatectomy. The patient was operated upon one week ago; he was able to be up and walking about two days after the operation; he had more or less bladder control after the tube was removed two days after operation; the operation was quickly performed; the patient lost little blood and suffered nothing from shock.

## GUNSHOT WOUND OF THE PERIPHERAL NERVES

DR. HERMANN FISCHER read a paper with the above title, for which see page 56.

DR. KARL CONNELL remarked that the war now being waged presents a mass of nerve injury hitherto unapproached. During the first winter of the war when he was in France, the nerve cases were not sorted into special groups, but on a trip through Germany in March, 1915, he found these like other special injuries already assembled and grouped for more efficient treatment. Thus he came superficially in contact with many hundred of these cases. In considering the etiology of these lesions it was interesting to note that the nerve to be damaged need not lie directly in the path of the missile, but it suffices that the nerve lie in the zone of the intense radial hydrodynamic pressure produced by modern high power missiles. Thus nerves were seen the subject of paralyzing contusion, and subsequent traumatic neuroma, that lay a half centimetre or more outside the path of the bullet. The majority of the lesions, however, were from direct injury, by being clipped, pierced, severed or directly contused by missile, or pressed upon by retained foreign body, or by subsequent callus and scar.

In considering the primary treatment of nerve lesions produced under the conditions which obtain in this war; it is theoretical to advise that severed nerves shall be primarily sutured when the wounds are clean, for practically the fresh wounds are never clean. Such fine pro-



transverse sections until such time as good nerve bundles are found in a group in the centre, one may oftentimes save an appreciable length of nerve, which is very important in getting good apposition. One can then proceed to remove the bulb all around the periphery until the nerve trunk is free with which to do end-to-end suture.

With regard to neuroplasty, the thing which is spoken of in all the books, and which is derived from the tendinoplasty, is an exceedingly illogical procedure. For instance, if one turns down a segment of nerve in order to get a bridge, it is a thoroughly established fact that the moment you divide any nerve fibre from its central end you get degeneration, and it seemed to him exceedingly illogical when one is already dealing with a damaged nerve, to proceed to do further damage to the central part of the nerve. Therefore this method of procedure cannot be too strongly condemned. One certainly never can succeed in properly bridging a gap by this method.

The difficulty in using calf's arteries is to have a proper series of sizes always in one's pocket when one is dealing with nerve cases. It is a difficult thing to have a sufficiently large number of arteries so that one can fit the nerve with the artery. The artery must be comparatively near in size to the nerve that is to be put in it.

A considerable amount of experimental work was brought forward by Dr. Dean Lewis in Chicago in which he seems to prove that fascia taken from the individual and made into a tube, with the smooth side inside to act as the inner lining of the tube, would on the whole give the best method of bridging; that it was not necessary to fill that fascial tube with agar or any other substance, that the serum which would flow in there would act very well as framework down which the regenerating nerve fibres would find their way perfectly well; that fibrous tissue implanted in this way always led to scar tissue and thickening, he disproved by a series of sections in which after a few months the fibrous tube which he had used had melted in with the new nerve sheath so that you could scarcely tell at what portion of the nerve trunk the bridging had been done. It seems, therefore, since tissues taken from the patient himself invariably heal in that patient with less reaction, that this method would offer a more feasible manner of bridging the nerves.

DR. GEORGE WOOLSEY remarked that Dr. Fischer mentioned the care required not to rotate the nerve in nerve suture. This is a wise precaution, but is it necessary? One can rotate the nerve through 180 degrees and suture with the same results as when one sutures it as nearly as possible in its normal position. It is not possible to get one nerve fibre opposite another nerve fibre in suturing. At least it is a matter of

## GUNSHOT WOUND OF THE PERIPHERAL NERVES

was made before Dr. Lyle had any experience with the Carrel-Dakin method of treating wounds. During the spring and summer he had personal opportunity of applying this method. The brilliant results obtained would now lead him to modify the above statement.

DR. WM. O'NEILL SHERMAN, of Pittsburgh, by invitation, said that the point raised by Dr. Lyle was a very important one. He saw possibly fifty or sixty nerve suture cases in Paris. These operations were done, many of them, at the end of three, four, five, six and nine months and the end-results were not very satisfactory. Now, of course, the duration of time that exists from the time of the injury until the operation is an important factor; degeneration has taken place in the delayed cases and it is impossible to secure perfect functional results. He had seen enough of the Carrel method to be absolutely sure that the statement that these wounds can be sterilized is based upon sound reasoning; thousands of them have been sterilized. There is not sufficient evidence to say that the nerve wound should be sutured immediately and the wound sterilized, or whether the wound should be sutured after the sterilization, and the nerve resutured at a later date. The French surgeons had the same question up in reference to the use of plates, whether or not it would be wise to immediately plate fractures, or whether it would be best to sterilize the wound and plate later. At the present time, there are not sufficient statistics or evidence to draw any definite conclusions, whether the immediate suture of either nerve or bone is the best thing to do or whether or not it would be better to wait until after sterilization to apply the suture. He had one case in mind that he saw in Dr. Lyle's service; a very extensive shell wound of the buttock—a frightful wound, exposing the sciatic nerve at the notch. Under former methods of treatment that patient would certainly never have recovered within four to five months, but in six weeks the wound was united.

In speaking of Carrel's method, it is very unfortunate that many in the profession are very skeptical about it. They will not accept it until they have opportunity to work it out themselves; certainly it has been demonstrated in France by the best men there, that it is far in advance of any other method of treatment. The results secured in France should convince any surgeon and he should immediately accept it without the skepticism and criticism that is heard throughout the profession.

DR. TAYLOR said that it is important to save all possible nerve length for suture. It has been his experience in dealing with these cases to find that the main trunk of the nerve will come well down into the bulb before the nerve fibres begin to turn around, and the dividing of the nerve transversely at its proximal end wastes valuable material. If one starts somewhere near the tip of the bulb and makes a series of

aged fifty-three years, who was admitted to the surgical ward of Bellevue Hospital, September 6, 1916, with carbuncle which covered the entire dorsum-of his neck.

When Dr. Vosburgh came on service on October 1, this man was in the ward with a sloughing area, the extent of which can be seen in Fig. 1. He applied straps to the area and after a period of strapping lasting for a week or two, he had the appearance seen in Fig. 2.

The skin had been so undermined by previous incisions that as the wound was strapped the skin on the left side began to turn in so that skin was growing on skin. This flap he dissected out and straightened it out so that it covered a part of the neck, where it was held in place by means of a suture which led over to the opposite side of the neck. This narrowed his wound to a considerable degree.

On October 14, he skin-grafted according to the Thiersch method by grafts removed from the thigh. These were transferred to a piece of rubber tissue approximately the size of the area to be grafted, the grafts being placed on the tissue with the raw surfaces uppermost. The grafts were then placed over the granulating area, and the rubber tissue removed. Very slight shifting was necessary to bring them into their proper position. The grafts were held in place by adhesive plaster laid directly on them, fixed on either side to the firm skin of the neck. This method of applying adhesive plaster directly to the Thiersch graft has been tried by a number of men who have reported that it has met at their hands with considerable success.

There is just one word of caution, or, rather, one very essential part of the procedure—that the operator himself should do the first dressing of the grafts. On removal of the adhesive straps, it will often be thought that the grafts have failed; but if the wound is allowed to dry a little, and is then viewed by oblique illumination, it will be seen that the areas which look red and raw are actually covered by epithelium.

Notwithstanding the extensive area presented in this case one attempt was sufficient to cover it with possibly 90 per cent. of "takes." The adhesive straps used were sterilized in the alcohol flame and interrupted but very slightly. There was a considerable discharge between the straps, and the entire dressing with the straps was removed on the sixth day. Ninety per cent. of the area had taken. The very small areas where the grafts had failed were in the neighborhood of the undermined skin. These closed over very rapidly under a continuation of the strapping of the wound with adhesive plaster.

The preliminary treatment of this neck, previous to operation, was by compression strapping with adhesive plaster. No antiseptics were

## CARBUNCLE OF THE NECK

luck. As Kennedy has shown, the nerve centres are readily re-educated to the changes in the path of nerve impulses and on this depends the possibility of nerve anastomosis.

The channels along which certain nerve fibres pass to certain muscles, is another question. He was not thoroughly acquainted with Stoffel's work. It has previously been held that the fibres which pass into a branch of a nerve are not collected together, that they are separated in the nerve itself until shortly before that branch is given off. If it were not the group of muscles supplied by a branch would be liable to complete paralysis in nerve anastomosis. In the peroneal nerve, for instance, we could never make the nerve plastics that we do. We could never make plastic operations on nerves without the danger of completely paralyzing groups of muscles, because we would be liable to cut all the fibres which pass to those muscles.

As he understood the reference, Stoffel holds that the fibres pass to the tibialis anticus, for instance, on the side of peroneal nerve next to the biceps muscle, etc. It seems to him that there must be some error there for experience in plastic nerve operations and nerve anastomoses has been quite incompatible with it. We don't get such complete paralysis of muscle groups by the partial division of the nerve trunk without regard to the part of the nerve divided.

DR. TAYLOR said that Dr. Woolsey's remarks should not go entirely without further discussion. Bundles of nerve fibres going to individual muscle bellies run together for a considerable distance in the nerve trunk before separating as a branch. That is proved by starting with a branch that runs to muscle and separating it up almost to the origin of the whole trunk which is done readily and without cutting across fibres. Stimulation of such nerve bundles will cause contractions in the muscle to which that branch goes.

In other words, Stoffel's point is well taken, and while it is impossible to divide a nerve and then to get individual axis-cylinders approximating to their corresponding fellows in the other end of the nerve, it does seem that we ought to attempt to do that just as much as we can.

*Stated Meeting, held December 13, 1916*

The President, DR. CHARLES N. DOWD, in the Chair

### CARBUNCLE OF THE NECK: SKIN GRAFTING

DR. ARTHUR S. VOSBURGH, to illustrate the method for skin grafting, which was presented before the Society and was recorded in volume v, page 891 of the ANNALS OF SURGERY, presented a man,





FIG. 1.—Before grafting.



FIG. 2.—The grafts applied.



FIG. 3.—The result.

## RESECTION OF CÆCUM AND ASCENDING COLON

DR. ARTHUR S. VOSBURGH presented a man, aged twenty-six, who was admitted to the hospital on June 18, 1915, with the following history: He was born with a rupture, which, during childhood and early adult life, gave him no discomfort, but which, for some time past, has increased in size, until it is now as large as a grape fruit. He states that when he stands the mass descends into scrotum, but that when he lies down it reduces itself. He complained of no pain. Upon examination the right external ring was found to admit more than four fingers, a large mass was felt in the right inguinal region, and the right testicle was not palpated. The tentative diagnosis, right direct inguinal hernia, with undescended testis, was made.

Accordingly, on June 21, an incision was made over the right inguinal region, disclosing a distinct sac, at the back of which were found rudimentary elements of the cord. The vas was followed down to the undeveloped testis. A reducible mass which, previous to operation, had been thought to be the undescended testis, was now found to be the cæcum, appendix, the entrance of the ileum into the cæcum, and the tumor mass within the cæcum, in the neighborhood of the base of the appendix. Manipulation failed to dislodge it. In the mesentery of the appendix and in the ileocæcal angle, several large, moderately hard lymph-nodes were felt. As it was thought the mass was a neoplasm, the wound was closed in the usual manner for the Bassini operation.

A right rectus incision was made. After opening the abdomen, the intestine, cæcum and ascending colon were examined. The cæcum, colon, and four inches of the small intestine were mobilized, and a resection of this part of the gut was done by the aid of clamps. The divided ends were sutured and inverted with chromic catgut, and further invaginated with a purse-string suture of Pagenstecher. A lateral anastomosis between the terminal ileum and the colon was effected, and the retroperitoneal bed covered, as far as possible, by drawing the leaves of the mesentery together. The wound was closed and drained, and a dry dressing applied.

His recovery was uneventful. The day after operation he voided voluntarily. Seven days post-operative his bowels moved naturally. On the fourteenth day he was up, "feeling fine." On July 10 he was discharged home, to report to the Out-Patient Department for the removal of the straps.

On November 21, 1916, just seventeen months post-operative, he returned to the Follow-up Clinic. An unsuccessful attempt had previously been made to find the man. He is entirely without pain, has

## CARBUNCLE OF THE NECK

used; no cleansing of the wound at any time during these dressings except on the surrounding skin.

The lack of acceptance of this very simple method of dressing the graft may be due to the fact that operators think the graft has failed when in reality layers of epithelium from the graft have become adherent and viable. He had used the same method on burns of the back, shoulders, arms, and especially in parts of the body where, during their recovery from ether, the *patient* might dislodge the dressing. He had had uniform good results if autogenous grafts were used.

DR. MATHEWS said that he had been using the method of Dr. Vosburgh ever since he first demonstrated it to the Society and with better results than with any method previously employed. He had not liked the method of open-air treatment of grafts for the first few days, because they are likely to be raised from the surface of the wound by accumulations of serum and blood and secretions are likely to be retained by scab formation. The prevention of slipping of the grafts by this method has made it especially useful in the case of children and in adults on those parts of the body, such as the back of the neck, where there is such difficulty in keeping the parts at rest.

DR. W. S. SCHLEY thought that Dr. Vosburgh's case illustrated the wisdom of radical excision in a carbuncle of size; both for speedy cure of sepsis and quickness of repair. The danger in many cases is extension to the muscular planes of the neck. He remembered showing a case before the surgical section some time ago in which it was necessary to excise from the superior curved line of the occipital bone to the base of the neck. This case was in extremely bad shape, but he turned around and had a very excellent convalescence. He refused to have a skin graft and healed by granulation. The enormous area filled in completely and with no contractures. He went back to his trade, which was that of piano maker, and had perfect freedom and use of his neck.

The method of skin grafting that Dr. Vosburgh speaks of is certainly excellent. That is, putting very little dressing over the grafts. We have been accustomed to use grafts laid on rubber tissue and putting on as shingles, in layers overlapping directly and not disturbing the wound edges to any great extent, though, just enough to prevent sliding. He thought rubber tissue over the graft has worked better than the adhesive plaster direct in the grafting. It allows any drainage that may occur exit between the grafts. Grafting on a surface freed of excessive granulation certainly is very necessary to the adhesive quality of the graft. Adhesive plaster is applied directly over the rubber tissue and a light gauze dressing over this.





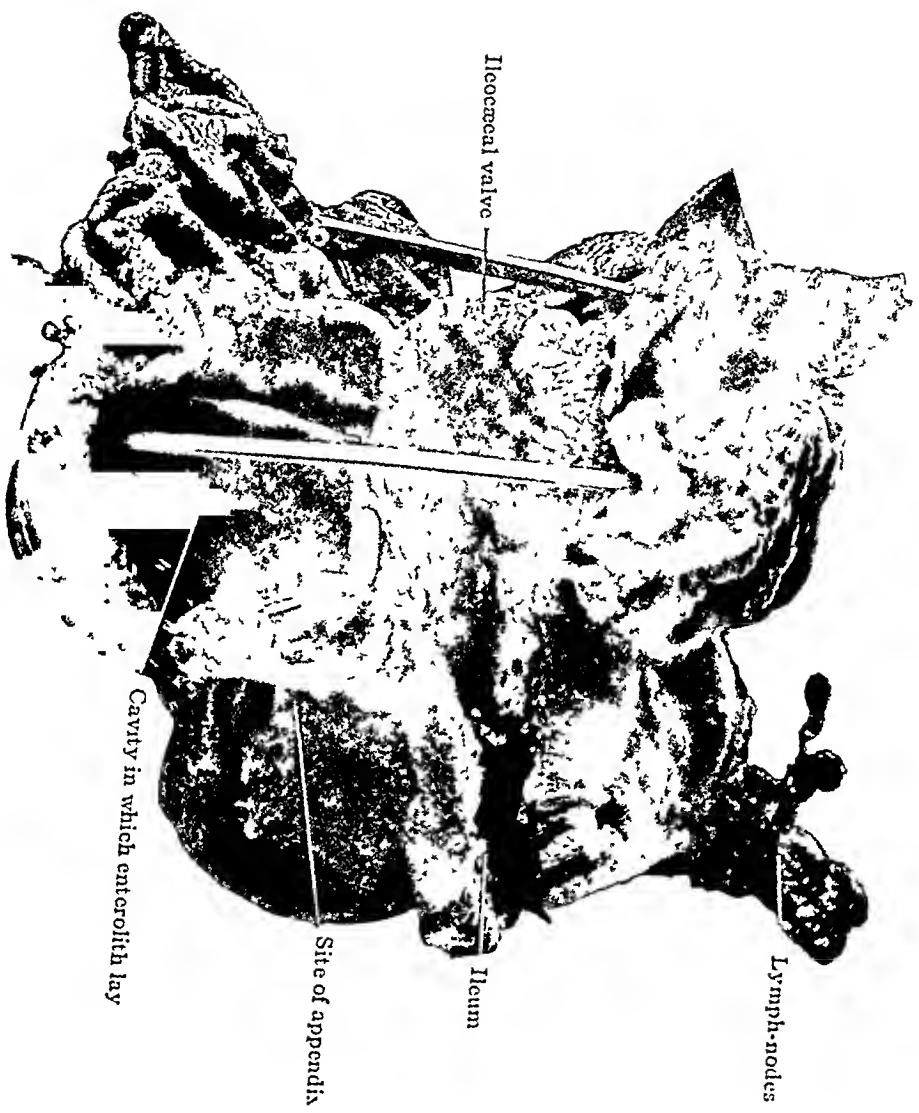


FIG. 4.—Diverticulum of caecum containing enterolith.

The pocket in which the "enterolith" lay was proximal to the termination of the tænia striæ, being formed in the greater part of its extent by a sacculæ which forms the caput coli, *i.e.*, this sacculæ lying between the anterior band and posterolateral band. The remainder of the pocket was formed by the left sacculæ, greatly diminished in size, which lies anatomically between the anterior tænia and on the posterior internal tænia. We must consider that portion of the bowel the large intestine which has tænia still arranged in bands, and must denominate that portion *appendix* where the bands are no longer discernible as entities. If we agree to the foregoing, we will see that the "enterolith" was lying in the terminal sacculæ to the right of the anterior band. The mesenteric glands can be seen in the picture. I may say that the microscopic examination of these discloses no pathological condition.

#### HYPERNEPHROMA WITH ABDOMINAL NEPHRECTOMY

DR. ROGERS presented a man whom he saw during the first week of July, 1916, with a history of very rapid loss of flesh and strength and with no other symptoms. There had been a decrease in weight during the last three months of thirty pounds. The urinary examination was negative. A physical examination revealed a considerable tumor in the right kidney region about six inches in diameter. Examination of the urine showed no abnormality but ureteral catheterization demonstrated that no urine was coming from the right ureter. The most probable diagnosis was hypernephroma. As the abdominal wall was thin and the tumor was apparently most accessible from the front, an anterior nephrectomy was chosen. On July 6, at St. Francis Hospital, the tumor was exposed by a vertical incision along the outer border of the right rectus muscle of about eight inches in length. Then very many extremely large veins were found over the surface of the tumor, which were divided between double ligatures.

After the retroperitoneal area was entered along the outer border of the ascending colon, to obtain better exposure, it became necessary to enlarge the vertical wound by a transverse incision on either side across the right rectus and well into the lumbar region. This allowed the veins to be divided between double ligatures, and in the course of these procedures a very large vein was found extending obliquely along the inner border and somewhat in front of the tumor. After some further dissection it was found that this was probably the inferior vena cava. Examination then showed that the tumor had absorbed the right renal vein and projected directly into the interior of the inferior vena cava. Any attempt to remove such a tumor from the usual posterior lumbar incision, would probably have resulted disastrously.

## RESECTION OF CÆCUM AND ASCENDING COLON

no disturbance of function, except that occasionally he is constipated and takes a cathartic. His appetite, sleep and strength are all good. His weight is 145 pounds, an increase of five pounds. His strength, he says, is twice as great as before operation. He resumed work two months after operation, and his earning capacity is 100 per cent. of what it has ever been. Physical examination shows inguinal wound firm. Abdominal wound also firm, with very slight pain on deep palpation of right side. No masses felt.

The resection of the cæcum and ascending colon was done through a rather small wound. It was easy because of the very marked mobility of this portion of the bowel as it had descended into the scrotum. The pathological report of Dr. Morris is as follows:

Specimen (Fig. 4) consists of lower end of small intestine 6 cm. in length and the adjacent portion of the cæcum. The specimen had been put in formalin before examination in the laboratory. The wall of the intestine is somewhat hypertrophied. The lumen is contracted. The mucosa is markedly wrinkled and stained with greenish bile. The ileocæcal valve is narrow, and the mucous membrane of the cæcum surrounding the ileocæcal valve is greatly hypertrophied in one portion, forming a teat-like mass, say 1 cm. The appendix is 6 cm. in length, normal in size. The lumen admits readily a probe. The mesentery is short and fatty. Between the apparent opening of the appendix and the cæcum there is a large round cavity which is filled with a formed mass of fæces. The fecal mass appears through the narrow opening into the cæcum of this cavity which is formed by the wall of the cæcum. It is somewhat difficult to tell if the cavity wall was originally a part of the appendix, or if the cæcum itself has played a part in the formation of the cavity. The opening into the cæcum is about 24 mm. in length by less in breadth. The circumference of the cavity in the widest portion is about 6 cm. and the distance from the apparent opening of the appendix to the valve-like opening is about 3 cm. The edges of the cavity are formed by what appear to be separated mucous membrane. The mesentery is fatty, and there are a number of enlarged ileocolic lymph-nodes. The mucous membrane of the cæcum is hyperplastic, but without ulceration or hemorrhages.

*Anatomical Diagnosis.*—Large (chicken egg) enterolith of cæcum with ball valve formed of mucous membrane at origin of appendix.

The specimen has been pretty badly mutilated. That this was an enterolith of the appendix, a very common condition, can be disproved by inspecting the specimen. If the tænia of the large bowel be followed down, they will be seen to terminate at the base of the appendix.

Six months previously, while patient was in the fifth month of an otherwise normal pregnancy, she had severe abdominal pains which were treated by morphine.

Three weeks before admission she had "gall-stone colic" with pains in right upper quadrant and right shoulder. During this attack she had jaundice and clay-colored stools. On admission physical examination showed a well nourished young woman in marked abdominal pain. Pulse was very rapid and of rather a poor quality. Temperature and leucocyte count moderately elevated. Abdomen distended and rigid throughout.

There was a marked tenderness over the regions corresponding to a low gall-bladder and high appendix, also on left side corresponding to tail of pancreas.

The flanks were tympanitic. Patient was not cold; not sweaty; not cyanotic; not in a marked degree of shock which we usually associate with acute pancreatitis. As the patient had been sick forty-eight hours and was not in a condition of shock, this diagnosis was not considered probable. The diagnosis was acute peritonitis, cause—cholecystitis, possibly appendicitis, but the condition seemed atypical of either.

*Operation.*—Right rectus incision so as to explore gall-bladder and appendix. Appendix normal. No stone in gall-bladder and the gall-bladder was not distended. The peritoneal cavity contained considerable thin, cherry-red fluid. There were areas about 5 mm. in diameter of fat necrosis over quite a diffuse area of the peritoneum. The pancreas could be felt as an extremely hard mass, the head being as large as a man's fist and the body as large as the wrist. The transverse mesocolon was made taut by lifting the transverse colon and greater omentum and the oedematous thickened layer over the pancreas was opened about 3 inches and the pancreas was penetrated with closed scissors along its length as far as possible, the scissors being opened vertically so as to tear the pancreas and establish some drainage. (The patient's condition did not seem to warrant a more elaborate operative procedure than this rapid drainage through the most accessible route.) Two large cigarette drains and a rubber tube were then introduced into this pancreatic retroperitoneal space and all the drains were surrounded by a rubber dam, the lower edges of which were tucked into this space. The drains as a whole were about two inches in diameter.

The condition of the patient did not warrant further exploration of the biliary tracts nor drainage of the gall-bladder which did not seem imperative. Drainage was profuse. Thirteen days after operation there began a profuse bile discharge from wound which persisted for

## ACUTE HEMORRHAGIC PANCREATITIS

A long curved clamp with the blades protected by rubber tubing was placed laterally on the vein and the tumor with the portion which entered the vena cava removed. The wound in the vena cava was closed by a suture and the clamp removed. The abdominal wound was closed in layers without drainage, and the recovery was entirely uneventful, and the patient left the hospital at the end of three weeks.

In spite of the large crucial incision there has been no hernia and the abdominal wall is as sound as can be.

After this operation the reporter did not see the patient until the middle of October. He then told him that before he left the hospital he felt in his parotid gland a small swelling which apparently had escaped the observation of those in charge. When he appeared in October the swelling in the left parotid was very firm, scarcely movable and extended quite deeply under the angle of the jaw. It did not seem worth while at that time to attempt further operations. Therefore he advised the application of radium, which was done by Dr. Janeway in the General Memorial Hospital on October 18. Since that application the swelling has decreased very perceptibly in size. There was a very severe reaction at the time with a great deal of swelling and inability to open the jaw. Now the mouth can be opened at least a half inch more than it could before the application of the radium. Dr. Janeway, before applying the radium, excised a fragment of this tumor tissue which was later reported to show the characteristics of a hypernephroma.

## PINNING OF FRACTURE OF RADIUS

DR. MORRIS presented a boy who had a fracture of the radius-ulna which is being held with a pin in the radius. The fragments could not be held with ordinary splints. The pin was introduced through a small incision while the bone was visualized behind a fluoroscopic screen.

## ADEQUATE DRAINAGE IN OPERATIONS FOR ACUTE PANCREATITIS

DR. FORBES HAWKES read a paper with the above title.

## ACUTE HEMORRHAGIC PANCREATITIS

DR. POOL presented a woman, nineteen years of age, who was admitted to the New York Hospital thirty-seven days ago, with the following history:

She suffered from acute abdominal pains which started forty-eight hours previously as generalized abdominal pains sharp and cutting in character. She vomited once, a large amount of yellow fluid. There had been no bowel movement in two and one-half days.

felt like a triangular ear of corn extending from right to left across the upper abdomen).

*Operative Procedure.*—The incision was made through the right rectus muscle. The gastrohepatic omentum was opened and a drain inserted down to the head of the pancreas. The pancreas was not incised. The abdominal wall was then closed by layers, except for a rubber tube and gauze drain. The temperature at the time of operation was 100° F.

After the operation the patient complained of great pain for several days. This was controlled by morphine. There was drainage through and at the side of the tube for several days, but, as the wound was kept protected by alboline, there was but little excoriation. She continued to have some pain a month after the operation, and it is recorded in the bedside notes that she vomited on five days at this time and again later, on several occasions. She was discharged cured on July 25, 1913. There is no record of sugar in her urine, and a recent examination shows no reduction by it of Fehling's solution.

DR. CHARLES H. PECK presented a woman, thirty-five years of age, who was operated upon two years ago for supposed acute cholecystitis. The gall-bladder was acutely inflamed and contained calculi. In addition there was a large abscess of the head of the pancreas. After performing cholecystostomy, the abscess was opened by incising the overlying peritoneum and forcing blunt forceps into the mass. A considerable quantity of pus was evacuated; the opening was made above the transverse colon.

The cavity was sponged out and a good sized drain placed down to it. Another was carried down below the gall-bladder and the wound closed. The patient made a rather stormy convalescence, but recovery continued steadily. The wound continued to drain and she left the hospital on June 5, with wound still draining. The drainage seemed to contain some pancreatic fluid and she was referred to the Out-patient Department, where she was under the care of Dr. Stillman for some months.

It took nine months for it to close completely and in the interval necrotic pieces of tissue would escape which were probably pieces of sloughing pancreas. There is nothing of particular interest in the convalescence since then, except that she has continued in good health and has had no evidence of sugar in the urine at the time nor during her convalescence.

She has a rather weak spot in the cicatrix but no true hernia, and complains of some pain there.

## ACUTE SUPPURATIVE PANCREATITIS

two weeks. Three weeks after operation wound had become infected with *B. pyocyaneus*; wound irrigated with one per cent. acetic acid in normal salt solution; and wet pads of same applied locally. Pyocyaneus infection disappeared rapidly. Patient was up and about the ward less than five weeks after operation. Discharge entirely ceased at this time.

There never has been any glycosuria; bile was present in urine for a time. Examination of stools November 21 showed an absence of bile.

## ACUTE SUPPURATIVE PANCREATITIS

DR. NATHAN W. GREEN presented a woman sixty-four years of age, a patient of Dr. E. W. Gould, who was admitted to the Surgical Service of St. Luke's Hospital, May 26, 1913, at 9.40 P.M.

Her history upon admission was that of pain in the upper abdomen. Her present illness commenced four days previous to admission, when she began to have pain in the abdomen, especially marked in the pit of the stomach. This remained constant up to the time of admission. She had slight fever and vomited once. Bowels have been constipated.

Her past history shows that she had "gastric dyspepsia" for years, but never vomited any blood or passed any by rectum. She had a similar attack to this ten years ago without operation. She has had several children. Her history aside from the foregoing was irrelevant.

Physical examination revealed the following: The patient on admission looked acutely ill. There appeared to be some fever and a pinched expression of the face. Pulse was 85 per minute and of fair force. Examination of her eyes and chest showed nothing strikingly abnormal. Her abdomen was obese, but there was no distention. There were pain and tenderness in the epigastrium, right and left of the middle line. There did not seem to be much rigidity, nor was there tenderness over McBurney's point, nor was there anything definite in the gall-bladder region. Her extremities were normal.

Owing to her pain and tenderness in the epigastric region and to her appearance of being acutely ill, an exploratory operation was thought advisable, and this was performed at one o'clock in the morning of May 27.

*Operation.*—Dr. Green. Anæsthetic, gas and ether by Dr. Stout. The operation consisted of an exploratory incision and drainage through the lesser omentum down to the pancreas.

*Pathological Findings.*—The gastrohepatic omentum was adherent to the posterior abdominal wall occluding the foramen of Winslow. The head and body of the pancreas were large and hard, and several drops of pus were seen on the anterior surface of the head (the pancreas



The abdomen was washed out and closed and the patient recovered. In that case the pancreas was not felt.

In the other cases he had had, he had generally drained through the gastrohepatic omentum, occasionally through the gastrocolic omentum. He believed it to be desirable, if possible, to split the peritoneum overlying the pancreas.

One extraordinary case which he had reported to the American Surgical Association was first drained, then the first incision was enlarged; then a secondary drainage opening was made through the right loin and penetrating into lesser peritoneal sac. Then finally a perforation of the posterior stomach wall occurred, probably pancreatic digestion, and after suturing this the patient recovered.

Most of the cases have occurred in obese alcoholic men or very fat women. One notable case was at the Bellevue Hospital about two years ago—a very fat woman in which anterior drainage through the gastrocolic omentum was used. The patient had practically recovered, sat up in a chair and was about the ward, when she had a sudden relapse and died.

It had been his fortune to see quite a number of these very interesting and very unusual cases. The most striking thing about the hyperacute hemorrhagic pancreatitis is the one described as typical, viz.: they all have died within forty-eight hours. A case of that type must die because destruction is so intense it makes no difference what one does. In other types definite and adequate drainage may accomplish much.

DR. CHARLES H. PECK said that he had a second case of acute pancreatitis shortly after the one he presented to-night. In this man a transverse tumor could be felt across the abdomen, as he was not very stout.

They did not know what the trouble was, but during the exploratory operation it proved to be a greatly swollen pancreas, three or four times its normal size. The easiest way of approach was through the gastrocolic omentum, between the stomach and the transverse colon, and it was drained that way. He pushed a blunt instrument into its substance at a number of places, drained down to the surface of the pancreas, and the man recovered.

In the first case the swelling was over the head and they approached it from the right side below the stomach. The abscess was opened below the stomach and above the transverse colon. The point that Dr. Hotchkiss brought up was a good one, that in pancreatitis all degrees of involvement are met with from the most acute types to the

DR. POOL said with regard to drainage, he thought that possibly Dr. Hawkes recommends too little drainage in the mild cases and too much in the severe and advanced cases. In cases of acute pancreatitis simply to put drainage down to the peritoneum over the pancreas appears insufficient because, if necrosis of the pancreas is present and advancing pressure should be relieved, such a procedure does not relieve pressure.

In the severe cases he did not think one has to drain the peritoneal cavity at several sites, but should establish adequate retroperitoneal drainage from the pancreas itself. In some cases, as in the one presented by him, this apparently may be done to advantage through the mesocolon. In this case a right rectus incision had been made, as is frequently done, under the impression that the lesion is cholecystitis or appendicitis. Through this incision ready access to the pancreas through the gastrocolic omentum may not be obtainable, whereas the pancreas, especially its head, part of which lies on a plane below the attachment of the mesocolon, may be easily reached through the transverse mesocolon. With the right rectus incision drains pass obliquely outward and downward from this site and are not interfered with by the great omentum, as they would be if they were introduced through a median incision.

DR. ROBERT T. MORRIS said that Dr. Pool's experience had been exactly his own and his view in the matter in regard to drainage is much the same. It seemed to him that in the mild cases one may not always know whether they are going to become more severe. He had in mind one case in which he did not incise the pancreas, that subsequently sloughed. So far as he could observe the entire pancreas came out through the incision and the patient recovered and lived for a year or two before dying of diabetes. Incisions into the pancreas might have saved it.

DR. LUCIUS W. HOTCHKISS remarked that he had had a number of these cases, and had been impressed with the fact that they fall, roughly, into three classes: The hyperacute hemorrhagic pancreatitis, all of which die; the acute suppurative pancreatitis, so-called, in which an operation may be effectual; then the so-called acute cases which are really subacute and in which surgery is very often effectual.

His first case of this type he saw several years ago: A woman who had been seized with severe abdominal pains and sent to the hospital where the examination showed abdominal pain, fever, and distention. He opened the abdomen and discovered, scattered about, many small fat necroses. He had never seen a fat necrosis before.

# CORRESPONDENCE

## THE KERR SUTURE

EDITOR OF ANNALS OF SURGERY:

The January ANNALS contains a splendid article on "Temporary Colostomy," by Shaw and Hunt, in which the authors refer more than once to "the Kerr suture." The illustrations show that they are speaking of the suture used in a new method of intestinal anastomosis evolved by Dr. Edward Mason Parker and Dr. Harry Kerr, and described by them in the *Johns Hopkins Bulletin*, vol. xix, No. 206, May, 1908. This is generally known as the "Parker-Kerr suture"; it is so described in Moynihan's "Abdominal Operations," 3d ed., vol. i, p. 306, and in the literature generally, including Dr. Kerr's own publications.

JOHN A. FOOTE.

WASHINGTON, D. C., January 24, 1917.

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## OMISSION

To the name of the author of the paper on "The Cœliac Artery," February ANNALS, p. 159, Benjamin Lipshutz, M.D., should have been added the words: Corinna Borden Keen Research Fellow of the Jefferson Medical College.

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most chronic ones. The very violent ones go on to rapid necrosis and die almost always. He had had two of that type that died very promptly after operation. He saw one unoperated patient die and on examination there was found complete gangrene of the organ. Then, a type such as the second case he referred to, can fairly be classed as acute though they approach the subacute type.

He had two cases in mind, one in the hospital now and one operated upon two years ago, in which the swelling of the pancreas was so great that it was difficult to know whether to class as a chronic or as a mild degree of acute pancreatitis.

It seems to him one can see a whole series from the very acute fulminating type down to the real hard chronic type, and in that series almost any degree of acuteness in the process. It is important, where it approaches the acute, to incise the peritoneum over the pancreas and secure drainage by pushing the finger or blunt instrument into the substance of the pancreas.

He had never felt it necessary to drain the pelvis or lumbar gutter.

DR. FRANZ TOREK called attention to one case which he drained exclusively from the dorsal region. That was a case in which he had made the diagnosis beforehand, which is out of the ordinary. He proceeded by making an exploratory abdominal incision and found the tail of the pancreas greatly swollen and œdematous.

With one hand in the abdomen on the tail of the pancreas and the other hand outside on the back he made a comparatively small incision (large enough for two good-sized drainage tubes) down to the pancreas, perforated its posterior wall, took out the pus and introduced the drainage tubes. The patient made a very smooth recovery. This is the only case that he had drained from the posterior route. He described this case and some other cases of pancreatitis eight years ago.

DR. ALEXIS V. MOSCHCOWITZ said that the method of approach should be selected to fit each particular case of pancreatitis. In some cases the approach through the gastrohepatic omentum is indicated; in others that through the transverse mesocolon. In a number of cases Dr. Moschcowitz had exposed the pancreas between the stomach and the transverse colon, and he has been so satisfied with the method, that he avails himself of this opportunity to recommend it. Particularly in very fat individuals this method is somewhat more difficult, but the after-treatment is superior and infinitely simpler, as it affords a direct method of drainage, without any of the inconveniences of kinking the tube, as might happen in draining through the gastrohepatic omentum, or kinking the transverse colon in draining through the transverse mesocolon.

of electricity than air, is liable to be struck. The electrical strain is taken up by every object in contact with the ground in proportion to its conduction and insulation.

Guerike, in 1650, was the first to discover the means of producing the electric spark (Flamarion). Nothing was known of the nature of lightning or of its relation to electricity until 1708, when Wall drew attention to the similarity of lightning and the sparks obtained by rubbing a piece of amber. Franklin in 1750 proved that the atmosphere was constantly in a state of electrification and with others demonstrated that lightning and electricity are identical. The degree of atmospheric electricity increases with the distance from the surface of the earth (Flamarion).

Lightning tends to obey the laws governing electricity. It is of such incomprehensible strength and the factors incident to its development are so imperfectly understood, that the laws controlling its dissipation have not been fully determined.

A flash of lightning is a rapid succession of (15-40) distinct sparks (1/5000 to 1/500 second duration) of progressively increasing length, projected along the same general path. The succession of sparks gives to lightning its flickering appearance. The entire flash varies from 1/1000 to 1/2 second duration.

The direction of the flash is a matter of dispute. It may take place to or from the earth.

The discharge usually takes place between the most prominent or proximal points. It follows the line of greatest conductivity or of least resistance. The charge may be so great that the main path is insufficient for its conduction. It may jump out of the main course, or form numerous branches (*Sc. Am.*, vol. 80). The course taken is determined by the intensity of the current and by the conduction or resistance encountered. The path may be altered by the wind or by the hygrometrical state of the atmosphere (Flamarion). These conditions account for the sinuous, spiral or irregular appearance of lightning.

Unsuccessful attempts have been made to determine the current-intensity, the frequency and the amperage of lightning. These have been variously estimated—voltage as high up in the millions (5000 millions). The frequency as medium (5000 to 300,000, *Emede Sc. Am. Supp.*, No. 697). The amperage upward of 10,000 (Brockels).

So long as resistance is not offered lightning is harmless (*Virchow's Archives*, vol. xx). Lightning will leap over a non-conducting surface

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## LIGHTNING—SOME OF ITS EFFECTS\*

BY CASPAR FRANK HEGNER, M.D.

OF DENVER, COLO.

EVERY action, chemical or physical, within the universe is accompanied by the generation of electricity.

Atmospheric electricity is generated by the friction of the wind and currents of air upon the vapor in the atmosphere, and by the molecular changes in this vapor, whereby they are converted into positive and negative electric ions (*Scientific American*, No. 106). The generation is more active when the vapor temperature is raised by the heat of the sun and later cooled by currents of air (*Scientific American*, No. 625; Henry, *U. S. Bulletin*, No. 30).

The earth is in a state of permanent electrification. The vapor in the atmosphere in condensing forms clouds, which in passing over other clouds and over the earth become charged by induction with electricity of opposite polarity to that of the earth.

Under ordinary conditions electricity in the atmosphere is neutralized by the insensible interchange with the electricity of the earth. This takes place in the form of usually invisible discharges, from the top of every mountain, hill, building, tree or metallic object. Discharges of this character take place from the human body, and when in high altitudes or on mountain peaks it may cause muscular rigidity and discomfort.

The electrical tension of the atmosphere may become very great. When the charges attain sufficient intensity that insensible neutralization becomes inadequate, the insulating air space is broken. The charges rush together and neutralize each other by a series of flashes, accompanied by the generation of light, heat and sound. Lightning is the term applied to this visible discharge of electricity.

The zone of danger may extend beyond the storm area (*Sc. Am.*, No. 625). Any upright or prominent object, being a better conductor

\* Read before the Western Surgical Convention, St. Paul, December, 1916.

mountain states of Colorado, Montana and Wyoming. Over sixteen hundred cases of lightning accidents are recorded yearly in the United States. One-third of these result in death. Nine-tenths of the deaths occur in rural sections.

Lightning has a tearing or explosive effect. It has a greater tendency to bend or break than to burn or fuse. The effects are largely mechanical, the result of pressure fluctuations. The disassociation of gases (*Virchow's Archives*, vol. xx) or the generation of steam by the current are claimed to explain many of these mechanical effects (*Lancet*, 1879-1909). The charge in passing through the body is not evenly distributed. It may remain superficial, follow channels, such as blood- or lymph-vessels, or be transmitted through bones and nerves.

The body may not be visibly affected, may be left in the same posture as before the stroke or thrown more or less violently many feet, and not injured (*Lancet*, 1909, vol. 1). Mutilation in varying degrees to complete dismemberment or incineration may result.

The clothing may not be affected in any way. It may be stripped or burned in part or entirely, shredded to ribbons, either warp or woof may be destroyed. Seams may be ripped, linings or undergarments destroyed leaving the outer garments and the skin intact (Flamarion). Metallic objects in or of the clothing are bent, broken, more or less fused or not affected. The shoes most constantly show the effects of the current. People are usually standing when struck, the current then enters or leaves the body through the feet. The shoes, especially when dry or only partially damp, interpose a substance of increased resistance. One or both shoes may be affected. They may be gently removed, or violently thrown many feet, be punctured or have a large hole torn in any part, shredded, split, reduced to lint or disappear entirely. The soles may disappear with or without the heels. Any of the foregoing may occur and the person not injured or only slightly shocked.

*The amount of damage to the clothing or to the surface of the body is no index to the extent or the severity of the injuries sustained within the body.* Either may be disproportionately great or small.

As lightning travels faster than sensory impulses, or the tracts are blocked, the injuries at the time of their infliction are usually painless.

The symptoms may be divided into (1) external or mechanical, (2) internal or essential, (3) mental or psychical.

External or mechanical signs are most marked at the points of

more readily than through air. Insulation afforded by auto tires, etc., and the safety thereby conferred is a fallacy (*Sc. Am.*, November 7, 1914). *Protection does not lie in providing insulation or resistance, but in establishing a path of greater conductivity and of less resistance than the body.* Conducting bodies or objects are more liable to be struck but are damaged less than resisting bodies (*U. S. Bull.*, No. 56).

There is an uncertain periodicity associated with the frequency and the severity of electrical storms. They are more frequent in the temperate zones during the summer months and in rainy seasons. They are five times more frequent east than west of the Rocky Mountains, more frequent in high mountains and on open plateaus than along the coast, or in low altitudes, in wet, marshy districts more than in dry districts.

The geologic as well as the topographic character of a region exerts an influence upon the site and the severity of a lightning stroke (*Sc. Am. Supp.*, No. 24; *U. S. Bull.*, No. 15). Loam, sand, clay, marl, and chalk predispose in the order named. Rocks are not often struck. They may be split, moved in great masses, or their surface vitrified. Fulgurites may be formed when lightning strikes dry soil rich in silica. Any tree may be struck, in order of their frequency, poplar, oak, elm, conifer, walnut, ash and beech. The richer in starches and the poorer in oils the more susceptible are trees. When struck the tree may be split, separated into layers, splintered, broken off obliquely or transversely. It may be stripped of limbs or bark. The bark may be grooved vertically or spirally, may be ignited (2 per cent.), may be stunted or stimulated in its growth.

Buildings are susceptible in proportion to their size, height, nature of their construction and insulation.

Lightning is more frequent (five times) in rural than in urban districts. The more thickly settled and the better built a section is, the less frequent and destructive will be the lightning.

Occupations which keep one in the open, especially in sparsely settled or open districts, increase liability—cattlemen, woodmen, farmers, etc. Animals are more frequently struck than men. All species, even fish in ponds and streams, have been affected. When animals are struck they rarely survive.

No accurate statistics of lightning casualties are available. Most fatalities and the greatest property damage occur during the months of June and July. The largest number of deaths occur in the Mid-Atlantic states. The greatest proportionate mortality is noted in the



conducting the electric charge increases the resistance and admirably illustrates the law—damage is in proportion to the resistance.

Important vessels may be ruptured, cause alarming or fatal hemorrhage or irreparable damage. Any viscus may be lacerated or ruptured with or without damage to the overlying tissues. Eye injuries may result promptly in cataract. The choroid or choroidal vessels may be ruptured, retinal hemorrhage or detachment, paralyses of the muscular apparatus and of accommodation or atrophy of the optic nerve may occur (*Medical News*, 1888). Ear may be torn off, membrana tympani ruptured, or the auditory nerve injured.

The actual destruction of tissue resulting from the purely mechanical effects is of secondary importance, so far as life is concerned, to the interruption or the destruction of the physiology of the vital centres. This pathological physiology explains many of the internal or essential symptoms.

The internal or essential symptoms may be divided into primary and secondary.

Primary symptoms may be very slight: a mild sensation of giddiness or blunting of intellectual faculties. Loss of consciousness more or less complete, lasting from a few moments to days, may terminate in death. Return to consciousness may be sudden or by stages. Collapse with pale clammy skin, difficult, slow and irregular respiration, irregular feeble pulse, dilated pupils, may enter a state of suspended animation, during which there is neither respiration nor pulse. This lasts a variable period, usually short and if not promptly treated by artificial respiration deepens into death. Lastly and most awe-inspiring is instantaneous death without macroscopic lesion.

Secondary symptoms are in all probability dependent upon some tissue change. Loss of memory complete or confined to the accident, temporary or permanent. Aphasias of any kind may result. Growth of the affected part may be permanently stunted.

*Motor*.—Tonic or clonic contractures, rhythmical or irregular, general or confined to the injured part. Paralysis—mono, hemi, para or quadriplegia with or without involving the sphincters. Difficult mastication, deglutition or phonation. Vertigo, ataxia or loss of coördination. Convulsions, true epilepsy or epileptiform.

*Sensory*.—Pains, general or confined to the area affected, sharp, severe darting or paroxysmal in character or a dull ache. Hyper, para or anæsthesia.

Special sense—deafness, dulling of hearing or buzzing in the ears.

entrance or exit of the current. The nature of the injuries is determined by the position of the body, the condition of the skin, the character and condition of the clothing, the presence of constricting bands of metallic parts and the proximity of conductors and contacts.

The skin offers greater resistance than any other tissue. The resistance is five hundred times greater when dry or oily than when wet. This difference accounts for the wide variation in the character and degree of its injuries, which are burns, lacerations and contusions.

Burns range in degree, from singeing of the lanugo and mildest erythemas to complete incineration. They vary in extent from minute punctate to extensive irregular areas. Burns which at first appear small and superficial may later assume a more extensive and deep character. They may partially heal and later break down, not only in the scar but in the adjacent apparently healthy tissue. They take longer to heal than ordinary burns.

Erythema may be the only manifestation of lightning stroke, or may accompany burns—as a circumscribed area or as irregular, narrow or broad, more or less branching bands—the resemblance to trees, ferns, etc., giving rise to the popular fallacy of lightning photographs. It has been asserted that these peculiar configurations are due to vasomotor paralysis, and to disintegration of the blood in the superficial vessels and capillaries. They are not confined to the distribution of these vessels. Rindfleisch (*Virchow's Archives*, vol. xxv) proved they are due to the effect of the current on the tissues, the irregular and branching distribution being caused by the difference in resistance.

Vesication and pigmentation may accompany burns and erythemas as brownish areas, hard dry parchment-like or soft, with vesicles containing more or less altered blood.

Contusions, from the mildest, with slight ecchymosis, to the most severe degree, with extensive hæmatomas, may occur.

Lacerations may be single or multiple, clean cut or irregular. They may be superficial, confined to the skin, or deep, involving not only the subcutaneous tissues but also the muscles, fascias, vessels, nerves and bones. Either may be extensively involved without the other.

Joints may be dislocated, bones may be fractured. Fractures are direct, caused by the lightning, or indirect, due to muscular contraction, the throwing of the body, or by objects falling on the body. When direct they are usually comminuted or complex and occur at joints, particularly where several bones enter into the formation of the joints. *e.g.*, ankle and spine. A break in the continuity of the bony tract

stove with a metallic flue leading through the roof. The next thing she knew she was lying partly under the bed near a large hole in the floor. She experienced no pain, did not know what had happened or how long she had been unconscious. She says it could not have been long, probably a few minutes. When she tried to get up she noticed the front of her shoe was torn and the sole and heel entirely gone. The little toe was gone and her foot was bleeding badly. She called to Miss A., but received no response.

Miss A., who had been sitting in a chair near the middle of the living room, heard Miss V. close the window and remark about the storm. She heard nothing after this, but saw the stove lid fly across the room and heard it fall on the floor. Above the stove appeared a huge round flash of bright light the size of the sun. She tried to get up but was lifted from her position and thrown several feet through the open door to the floor of her room. She was dazed, her ears felt shut. She was aroused after a brief period by the cries of Miss V, which she heard as if in a dream. She could not move. By supreme effort, being unable to get up, she crawled to Miss V's room and found her sitting on the floor holding her foot. The sight of blood all over the floor brought her out of her dazed condition. She laid Miss V. on the floor, who on looking up through a hole torn by the lightning in the ceiling saw the cottage was on fire. The cottage burned completely. The nearby pine trees were also burned. Miss V. was carried to the adjacent ranch house and attended by Dr. H. L. Buxton who rendered efficient service, stopping the hemorrhage which seemed to threaten her life. Her watch stopped at 2.10 P.M., the exact time of the stroke.

I was sent to Grand Lake by Dr. G. W. Holden, and arrived the next A.M. Miss A. was entirely recovered though still very nervous, a state easily accounted for by the precarious condition of her friend Miss V. Miss V. was in a state of shock, under the influence of opiates. Lips cyanotic, skin pale, giving face a peculiar expression. Pulse 140, respiration 14 and irregular. Her left labia showed a superficial laceration the size of a quarter. Her left foot had a laceration, the surface of which appeared as if seared by heat, extending through the web between the big and second toe from the dorsum to the plantar surface of the foot back to and exposing the first row of tarsal bones. A second laceration through the web between the second and third toe through the entire thickness of the foot joining the first laceration near the base of the metatarsal bones. A third laceration 2 inches long through the web between third and

Blindness, blurring of vision, double vision, loss of color sense, lachrymation, photophobia, ptosis, loss of accommodation.

Mental or psychical neuroses may have a pathological basis. Functional traumatic neuroses, mental or intellectual impairment, insomnia, delirium, mania. Hypersensitive to electrical storms ranging from fear to positive pain.

Prognosis should always be guarded. When symptoms have no demonstrable pathological basis they are usually temporary but may last for months. Death may be instantaneous, a direct effect of the lightning upon the myocardium (fibrillation) or upon the respiratory centre, or both; more or less sudden, due to shock following the stroke or to gross lesion of the vital centres; slow, from delayed shock of the injuries, as a direct result of the injuries or consequent exhaustion:

The diagnosis of death due to lightning depends upon the presence or absence of positive findings at autopsy and upon the conditions and circumstances attending the finding of the body at the site of the accident. The post-mortem changes may be negative. Evidence of violence may be entirely absent. Body temperature may be elevated for a considerable period. Rigidity sets in early and passes rapidly. Putrefaction may set in early and progress rapidly.

Brain and nerve tissue being better conductors are more easily affected, but show less macroscopic damage than other tissues.

Findings may be those of asphyxia, congestion with or without ecchymosis of the cerebrum medulla or cord and their membranes. Heart is flaccid, right heart filled with fluid blood, the large venous trunk and veins congested, arteries contracted and nearly empty. Blood not coagulated or poorly coagulable. Ecchymosis beneath the pericardium, pleura or in the lungs. Evidence of violence or injuries before mentioned in the skin, muscle, bones or viscera. There are no reliable or constant cytologic changes in the material obtained from cases of death by lightning.

CASE I.—On August 3, 1916, Miss V. and Miss A. were sitting on the porch of their cottage which was located among the pine trees on the slope of a hill near Grand Lake, Colorado. A severe storm began and they went into the cottage.

Miss V., noticing the rain coming in the window of her room, closed it, but not before the floor became wet. She then sat on a commode. The commode was several feet from the bed near the living room partition, on the opposite side of which was a



FIG. 3.—Comminuted fractures resulting from direct explosive (lightning) violence.

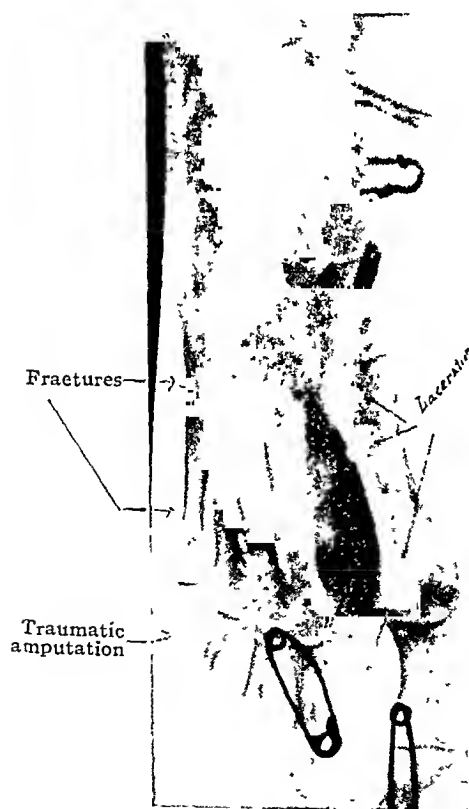


FIG. 4.—Extensive laceration through entire foot, exposing the tarsal bones, illustrating explosive or tearing effect of lightning.



FIG. 1.—Internal aspect.



FIG. 2 —External aspect.

# SOME OBSERVATIONS IN SPINAL CORD SURGERY

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UNUSUAL possibilities for the prolonged observation of the effects of spinal cord lesions, principally traumatic ones, and the effects of various operative procedures upon such lesions, exist in two surgical services to which I am attached. For the unlimited opportunity to study and operate upon these cases, I am indebted to Dr. Darrach, Director of the First Surgical Service at Bellevue Hospital, and to my colleagues on that service, and to Dr. Elsberg, Attending Neurological Surgeon of the Central and Neurological Hospital. The observations to be made are grouped under various captions; some of these are related but are separately presented to bring out certain points.

## FASCIA TRANSPLANTATION INTO DEFECTS OF THE SPINAL DURA

The problem of dealing with large defects of the dura, the necessary result of its sacrifice at operation, has not been adequately solved. When, for example, a large part of the posterior surface of the exposed dura must be excised because a tumor springs from it, suture of the defect in the ordinary manner may be difficult or impossible; even if the defect can be closed, the procedure is undesirable in such instances because of the resulting constriction of the cord. The latter holds true although no evidence of pressure upon the cord may be noted at the operating table. For it must be borne in mind that the considerable space normally existing between the dura and cord exists in part for the purpose of allowing free motions of the spine in all directions. In short, I believe that whenever a large defect is the result of the operative procedure or disease, the dural defect should not be closed by suture of its margins.

Some surgeons do not make any suture of the dura under such circumstances, but rely upon an accurate closure of musculature and aponeurosis in order to prevent leakage of cerebrospinal fluid. Besides the fact that this does not give absolute assurance against leakage, this technic is objectionable because adhesions between the cord and the adjacent sutured musculature must inevitably result. Others cover the defect with Cargile membrane, which is expected to remain securely in place and about which adhesions are not supposed to develop.

fourth toe involved the dorsum of the foot and the intermetatarsal tissues. A fourth laceration through the web between the fourth and fifth toes extended across the base of the little toe, completely amputating it, leaving only a fragment of the proximal phalanx. On the dorsum of the foot near the base of the second and third toes was a nearly circular burn of second degree the size of a silver half dollar. On the corresponding area of the sole was a burn of the same size and degree. Extending from two inches below the internal malleolus under the heel to its outer margin was an irregular laceration through which could be felt fragments of the fractured os calcis. One of these fragments had the posterior end of the badly shredded plantar fascia attached to it; two others were removed. There was a comminuted fracture of the lower end of the tibia and fibula, compound comminuted fracture of the os calcis and fracture of the third and fourth metatarsal bones, as shown on the accompanying X-rays by Drs. Childs and Crosby.

Without anæsthesia the wounds were gently wiped free of coagula with dry gauze. The plantar fascia which was reduced to a bundle of strings and the deeper tissues were united by tiers of interrupted catgut sutures, two catheter drains inserted, skin loosely approximated with interrupted silkworm sutures, leg placed on posterior splint. Patient withstood the ordeal with wonderful fortitude. She was sent to Denver the next day. For three days her temperature was 100, but never higher. She had severe darting pains in her back, leg and foot. Tactile sensâtion in foot and leg was normal. At the end of a week I sent her to her home in Chicago and reports tell of her favorable progress. She can now bear considerable weight on her foot which is practically healed.



spines and laminae it was evident that the sharp angulation of the vertebral bodies produced a similar angulation and compression of the cord with its membranes. As soon as the dura was incised its edges separated and the posterior surface of the cord projected into the gap. The purpose of the operation—relief of pressure on the cord—would evidently have been negated if the dura were resutured.

The erector spinae aponeurosis was exposed and its glistening surface carefully laid bare for the required distance. Avoiding undue handling, the under surface of the portion to be excised was gently separated from the muscle. An elliptical section,  $5 \times 1\frac{1}{2}$  cm., was then removed and turned with its superficial surface towards the cord. Four fixation sutures of fine silk, one on each side and two at the ends, approximated the cut edge of the dura to the margin of the transplant. A continuous suture of fine silk was then used to approximate the dural and fascial margins all around. The spaces between the stitches averaged about  $\frac{1}{2}$  cm., the sutures not being drawn very tight. In closing the wound it was evident that the two layers of muscle, usually found thick and amply protecting in laminectomies, afforded a thin covering for the transplant, so that it was clear that if leakage of cerebrospinal fluid occurred the fluid would appear under the skin or on the surface. The aponeurosis and skin were closed with interrupted sutures in the usual way.

The post-operative course was uneventful; there was no evidence of escape of cerebrospinal fluid. The wound healed firmly, and is at the present time (one year after operation) free from any untoward manifestations. Lumbar puncture recently made yielded fluid under normal pressure.

#### THE OPERATIVE TREATMENT OF RECENT SPINAL CORD INJURIES:

##### INDICATIONS AND CONTRA-INDICATIONS

It is almost universally agreed that the present-day surgery for complete crushes of the spinal cord is quite hopeless, and that such cases should therefore not be operated upon. A difficulty, however, rests in the differentiation of acute oedema, accompanying various lesions, from total destruction of the cord. The small minority of surgeons, arguing that it is not always possible to distinguish between these conditions, believe that operations should be performed in the hope that oedema will be the lesion found. They maintain that its relief by appropriate incisions of the cord may prevent total destruction. It has not been demonstrated clinically, however, that the diffuse oedema of the cord tissues can thereby be relieved, and it has not been

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Neither of these assertions has been proven to be correct for the spinal canal as far as I can determine. Whatever clinically satisfactory results follow such treatment of spinal dural defects depend, I believe, upon the careful approximation of the layers of the wound, and not from the implanted animal membrane.

Experimentally and clinically, defects of the *cerebral* dura have been adequately replaced by free autoplasmic transplantation of fascia lata. In a series of experiments I was able to demonstrate that defects of the spinal dura can be treated in the same way. In fact, fascia transplantation in the latter region was found to have distinct advantage over its implantation into the cerebral dura, for, in contrast, adhesions between the transplant and the underlying cord were not observed even after prolonged periods (more than one year). It is interesting to note that in these experiments the inner surface of the transplant sutured into a defect of the spinal dura remains smooth, and becomes lined with a layer of flat (mesothelium-like) cells continuous with the dural lining, and that the transplant becomes converted into an equally strong resistant layer of altered connective tissue.

The correct clinical method of treating large defects of the spinal dura, therefore, appears to be by transplantation of fascia. The latter (aponeurosis over the erector spinæ) is close at hand in spinal operations and the sacrifice of the necessary part for transplantation purposes is harmless. In reference to the technic to be employed, it may not be out of place to call attention to the fact that, as I have shown, the chances for the success of a fascial transplant into a visceral defect are far greater and more uniform if the transplant is sutured into and not over the defect. The technic and the result of the fascia transplant into the spinal dura are given below in the one instance in which I have had the opportunity to employ the procedure.<sup>1</sup> It will be seen that there was no leakage of cerebrospinal fluid (although the layers of muscle that could be approximated over the transplant were unusually thin and atrophic) and that no untoward effects from the transplant are to be observed at a considerable period of time after the operation.

Ellen C., fifty years old, was operated upon for post-traumatic deformity of the lower dorsal spine (Kuemmel's disease, reported in detail in another place) in the Central and Neurological Hospital, in March, 1916. The musculature on either side of the very marked deformity was pale and atrophic. After removal of the

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<sup>1</sup>A second case in which it was employed is too recent to give final results; the immediate outcome was very satisfactory.

column. This is especially the case when the bodies of the vertebræ are considerably damaged; and even more so when an extensive injury is confined chiefly to the bodies.

3. The difficulties in immobilization after operation are enhanced because of the necessary removal of spines and laminæ, and are increased in proportion to the amount of bone removed. It becomes a problem to determine the exact position in which the spine should be fixed. This holds true particularly in the cervical region. As an illustration of the difficulties in immobilization, the following case may be mentioned:

A patient admitted to Bellevue Hospital was suffering from extensive fractures of the laminæ and bodies of the fifth and sixth cervical vertebræ, with the evidences of compression of the cord at those levels. At operation the loose fragments of bone were removed and the cord was found not to be directly compromised by them. The only visible evidence of injury to the cord was a patch of œdema. After closure of the wound, a posterior plaster-of-Paris moulded splint was applied. There was gradual improvement in the manifestations of the spinal cord injury until the fourth day after operation. Evidences of progressive loss of cord function then supervened. The splint was removed. It was found that it had slipped upwards slightly, this resulting in some abnormal flexion of the head. When the head was permitted to fall back in a more normal posture, the manifestations promptly receded.

4. The important muscular support given the spinal column by the erector spinæ must be greatly diminished by operation, because of the necessary division and retraction of the muscles for exposure of the operative field and the subsequent temporary paresis or paralysis.

5. The preparations for operation and the immediate post-operative immobilization are all fraught with danger of additional damage of the spinal cord out of proportion to what can actually be done for relief in most cases, it seems to me. The patient must be transferred from bed to stretcher and operating table, and distortions of the spinal column may thereby result. He may struggle during anæsthetization, and this may result in further injury. It is necessary to roll the patient to the prone posture on the operating table, and loose fragments may as a result be pressed against the cord; this holds particularly, I believe, for the necessary fixation of the head for cervical laminectomy.

6. The operation itself is unquestionably an added danger, for

proved, nor is it clear from our knowledge of the pathology of œdema, that such destruction must necessarily occur without incision of the cord. On the contrary, the many reported cases of total paraplegia following cord injuries in which improvement or even complete relief has supervened without operation must, in the absence of more precise knowledge, be considered instances in which œdema was an important part of the pathological condition.

There is far less uniformity of opinion as to the operative indications for the varying degrees of injuries to the cord short of complete destruction. The more radical view urges operation for this group of cases in the expectation of removing fragments of bone pressing on the cord, straightening out angulations, etc. The indication for operation, according to the conservative standpoint, may be summed up in the statement that it exists when there is progressive increase of the manifestations of the cord injury. Put in another way, one should wait, according to the latter view, for evidences of increasing damage to the cord; according to the former view, one should not wait to see if the patient will recover more or less completely without operation.

In reading some of the voluminous literature upon the subject, I could not arrive at a conclusion as to the indications for operation more definite than that I have given. It is futile to dismiss this important question by stating that it depends largely upon personal experiences, varying technical ability, etc. There has been ample opportunity to observe the results obtained by various surgeons, and, though operative technic unquestionably plays an important rôle, it appears to me that they depend much more directly and definitely upon the operative indications that had existed. I shall present a number of reasons for assuming an extremely conservative stand for surgical interference in spinal cord injury, and then offer two indications for operation:

1. In the great majority of cases, whatever damage has been done to the cord cannot be undone by operation. Fragments of bone that have bruised or lacerated the cord have in many instances sprung back so that it is rare to find, at operation, a fragment of bone actually pressing upon the cord. Not a few cord injuries exist either in the absence of a demonstrable fracture or with fissure fractures of the vertebral bodies and laminae.

2. On operation, partially or completely detached fragments of bone are often found here and there in the musculature. Particularly in the cervical region, some of these have helped to support the injured part of the spinal column and their necessary removal for exposure of the cord means that much greater possibility of collapse of the spinal

tents of the spinal canal not infrequently exist in the absence of any lesion demonstrable by röntgenography. I do not refer to dislocations, chiefly to the cervical vertebræ, in which it is presumed that reductions have spontaneously occurred, but to cases in which there is undoubted evidence of injury within the dural sac (as shown by the presence of blood in the lumbar puncture fluid and neurological manifestations referable to a definite cord level), particularly of the dorsal and lumbar regions. Repeated X-ray examinations, with the tube squarely focussed on the suspected vertebræ, have in such cases failed to reveal any abnormalities even when exceptionally clear röntgenograms were obtained. It is not within my province to inquire if this fact is referable to the limitations of technic or to the absence of any fracture, although I believe that most röntgenologists will concede that fissures of the bodies of the dorsal or lumbar vertebræ may not show in the X-ray plate. My purpose is only to emphasize the fact that a negative röntgenogram by no means excludes the existence of an intradural injury. The following case is a striking example:

A man was admitted to Bellevue Hospital with the history of having fallen from a stoop, landing on his back, twenty-four hours before. The neurological evidence pointed to a lesion of the spinal cord, of an irritative rather than a destructive type, opposite the tenth to twelfth dorsal vertebræ. Lumbar puncture revealed considerable blood. Repeated X-ray examinations of the spine, with anteroposterior and oblique pictures, and sharp focussing of the tube on the presumably fractured vertebræ, were entirely negative for fracture.

As a further commentary upon the limitation of the X-rays for the diagnosis of fracture, the subsequent course of the above case is of interest. Progressive improvement occurred, the patient regaining power in both lower extremities and normal bladder control. At the Central and Neurological Hospital, to which he was transferred, the patient insisted upon being up and about, and left the institution against advice. When seen not long after, abnormal prominence of the spinous processes of the ninth, tenth, and eleventh dorsal vertebræ was noted. Without treatment this deformity will probably be progressive and the typical picture of Kuemmell's disease (*q.v.*) may ultimately develop. In consideration of the negative röntgenograms, how shall such a case then be classified, as one of Kuemmell's disease, in which fissure fractures of the vertebral bodies was the cause, or one in which traumatic softening of the bodies ("trophic" disturbances, etc., as maintained by some writers) without fracture was the etiological factor?

## SOME OBSERVATIONS IN SPINAL CORD SURGERY

patients are often not in good physical condition for many evident reasons. The operative mortality must, therefore, be considered in counterbalancing the possible relief that may be given.

7. Typical laminectomy cannot be carried out in many cases because the landmarks are so often greatly distorted. In not a few instances the position of the cord can only be guessed at. As a result, it may be further injured in the removal of loose fragments of bone, and in the other procedures required for its exposure.

8. The primary manifestations of severe cord injury may clear up in great part without operation; similarly, the residual evidences of a mild injury to the cord can certainly be very slight indeed.

9. The immediate after-effects of laminectomy must also be considered. The patient requires a more prolonged stay in bed because of diminished support to the vertebral column when the bodies of the vertebræ have been fractured, and complications therefrom (pressure ulcers, anæmia, etc.) must be borne in mind. Furthermore, the after-effects of operation may consist in a definite weakness of support of the spinal column.

The question of indication for operation is, of course, entirely different when, after adequate observation, it is evident that the improvement in the primary condition has progressed as far as possible. The persistence of such symptoms as severe pain, spasticity, etc., may call for operation in the secondary stages. I wish to call attention to two definite indications which I believe are the only ones that call for operation for fresh spinal cord injuries in civil practice at the present time:

1. Progressive intraspinal hemorrhage as indicated by repeated lumbar puncture.

2. Unquestionable X-ray demonstration of a fragment of bone encroaching upon the spinal cord at the level to which the neurological manifestations point.

Neither of these is an absolute indication for operation if the manifestations of cord compression are not severe.

## THE LIMITATIONS OF RÖNTGENOGRAPHY IN THE DIAGNOSIS OF SPINAL INJURIES

The great value of X-ray examination in spinal injuries is too well known to require any discussion. In not a few instances, especially when mild traumata have been inflicted, it alone establishes the existence of a fracture of one or more of the integral parts of the vertebræ. It is not so universally recognized, however, that injuries of the con-

order to exclude possible trauma made by the puncture needle as the source of the blood.

The lumbar puncture demonstration of the absence of an intradural hemorrhage is, as has been said, of equally great value, not only in the diagnosis and in the indications for treatment, but also for the immediate and ultimate prognosis. For reasons advanced in the previous section, the presence of clear cerebrospinal fluid eliminates one of the two indications for operation for recent spinal injury. This is well shown in the following case:

The patient was admitted to Bellevue Hospital a few hours after having been flung against her spine in a street car accident. There was some evidence of a spinal cord injury, progressing steadily, so that, at the end of thirty-six hours, there was complete loss of power and sensation in the legs, and absent reflexes. The case seemed one in which there was progressive hemorrhage about the cord and for which operation was indicated. Lumbar puncture revealed absolutely clear fluid and operation was withheld. The reflexes of the lower extremities reappeared soon after. The patient is still under observation; the present course appears one of mild injury to the cord with superadded hysteria. At any rate operation is certainly contra-indicated.

The therapeutic value of the withdrawal of subdural collections of bloody fluid is evident, particularly in those cases for which operative procedures are not indicated; yet lumbar puncture for such purposes finds no advocates. If the spinal cord manifestations of recent injuries are due to compression or irritation by fresh blood, it is clear that removal of a part or all is desirable, not only for the relief of the immediate symptoms, but also to minimize the after-effects of the hemorrhage about the cord. Conceding that only a part of the blood can be removed by lumbar puncture, even that is, I believe, better than permitting all to remain. As a further step it may prove feasible to attempt to remove, by washing, some of the remainder. Up to the present time this has been practised in only one case. The immediate results were striking, but the final outcome is unknown for the patient was removed to his home a few days after. The report:

The patient was admitted to Bellevue Hospital with a fracture of the lower dorsal spine, profound sensory loss over the lower extremities up to the level of the twelfth dorsal segment, marked paresis of both legs, increased reflexes, Babinski, etc., and retention of urine. The catheterized specimen of urine showed the

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### THE DIAGNOSTIC AND THERAPEUTIC VALUE OF LUMBAR PUNCTURE IN SPINAL INJURIES

Unquestionably, the importance of lumbar puncture in the diagnosis of spinal injuries must be appreciated by many, yet evidences of the recognition of its true value cannot be found in the literature. Diagnostic lumbar puncture has proven of such great significance in the First Surgical Service of Bellevue Hospital that it is now employed as a routine measure in all cases of suspected or of evident spinal injury. Its value lies, of course, equally in the demonstration of the presence or of the absence of blood in the cerebrospinal fluid. This test has so aided in clarifying our views concerning the indications for operation for spinal injuries (as pointed out in the previous section), that the presence of large quantities of blood (and evidence, upon repeated punctures, of continuation of the bleeding) makes one of the exceedingly few indications for operation.

In other cases, the disclosure of blood in the spinal canal was the only evidence that vaguely suspected spinal injuries were in fact vertebral traumata with cord compression. Two such cases were seen. An impressive one was that of a man who entered the hospital in a profoundly shocked, semicomatose condition, with a history of a fall from a considerable height. When seen by me, immediately after admission, a contusion over the lower dorsal vertebræ was noted, but evidences of injury to the cord could not be elicited. Lumbar puncture disclosed the existence of active subdural bleeding. When the patient recovered from shock the signs of an incomplete injury of the lumbar cord were evident.

The groups of cases in which the presence of blood may be of unusually great value as evidence of the existence of spinal injury, with cord compression in most instances, are: (1) Suspected spinal injury in individuals suffering from acute or subacute alcoholism; (2) suspected injury in patients in coma or in confused mental states; (3) injuries suspected in cases of hysteria.

Blood in the spinal canal is not of such definite diagnostic value in cases of skull injury in which associated spinal injury is suspected, for, as is well known, blood in the cerebrospinal fluid may be the result of the cranial lesion. However, the presence of large quantities of fresh blood in the spinal canal when there are some signs of spinal injury points more to the latter as its source.

Small amounts of blood admixed with cerebrospinal fluid naturally indicate that less active hemorrhage is going on. The precaution should always be taken to collect the spinal fluid in two or three test tubes in



established, chiefly because necropsies are not obtained during its evolution. According to one group of observers the lesion is a fracture of the vertebral body which, when not distinguishable radiographically, is presumed to be in the nature of fine linear fissures. The theory of a rarefying osteitis without fracture has been advanced by others. The remarks made in the previous section have a definite bearing upon this question.

The treatment of Kuemmell's disease has, up to the present time, consisted in the application of plaster jackets and, later, lighter corsets, for the correction of the deformity, the prevention of its further development, or for the relief of pain. In many instances this treatment has been effective, in others it has failed. Although it often involves prolonged periods of incapacitation, immobilization appears to be the correct treatment for the majority of cases. It is not at all evident, however, that the method is equally logical if the late symptoms are referable in part or entirely to lesions of the spinal cord or cauda equina. In fact, immobilization relieved some but did not cure any of the reported cases of this type. One cannot understand, therefore, why operative treatment was not advised or practised here, for it is universally known that lesions such as adhesions about or angulation of the cord, nerve root irritation, etc., can be relieved by operation. I wish to advocate operation for the group of cases in question, basing my opinion upon these considerations and upon the results I have obtained by laminectomy in the following cases. In one there was prompt and lasting relief of pain and return of normal motor power following operation for Kuemmell's disease affecting the cauda equina. In the second, the relief from pain was equally prompt and the sensory improvement has been steadily progressive. The third case has shown no improvement, presumably due to the existence of syphilis and to the prolonged duration of the deformity and cord compression. The second case is particularly interesting as a demonstration of the presence of the cord lesion several vertebræ removed from the situation of the deformity. The first is the only one in which a fracture was found in the X-ray picture.

CASE I.—A drug addict, twenty-five years old, was admitted to Bellevue Hospital with the history that, four months before, crazed by the withdrawal of heroin, he leaped from a fifth-story window, landing on his feet. He was unable to walk and was put to bed. Fractures of the os calcis and external malleolus were found, and there was tenderness and pain over the midlumbar vertebræ. At first there was complete loss of power in the lower

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evidences of an advanced nephritis, so that operation was absolutely excluded except for the most stringent indications. Lumbar puncture revealed considerable quantities of fresh blood in the spinal canal. As much as would flow freely was withdrawn. Then repeated washings with sterile water were made until the return flow was no longer very deeply colored. Within two days the power in the legs had very greatly improved, the sensory loss was of a much slighter degree, and the patient voided voluntarily. It is of course impossible to say how much improvement might have occurred without this procedure, but the result is certainly suggestive.

### THE SURGICAL TREATMENT OF POST-TRAUMATIC DEFORMITY OF THE SPINE (KUEMMELL'S DISEASE) WITH SPINAL CORD SYMPTOMS

This condition, aptly termed "*Déformation Vertébrales Traumatiques Tardives*," by French writers, is far from rare, yet it is barely mentioned in American literature. More than 100 cases have been reported since Kuemmell, in 1891, first made the affection generally known. Its etiology, symptomatology, etc., will be referred to very briefly here (a detailed account being reserved for another place), for I wish to dwell upon the question of surgical treatment.

Post-traumatic deformity of the spine may develop after injuries ranging from mild to very severe, and from direct or transmitted violence. Three stages in the symptomatology can usually be recognized. The primary one is that of the immediate manifestations of the injury—more or less localized tenderness and pain over the spine, occasionally motor and sensory disturbances referable to slight and transient injury of the spinal cord or nerve roots, etc.—lasting for a very varying length of time, and of varying degrees of severity. The second phase, the "free interval," is characteristic. The primary symptoms and physical signs recede or, in some cases, disappear. The patient apparently is well, returning to his occupation in many instances. Occasionally the free interval is of very brief duration, or hardly can be said to exist; in most instances, however, it is quite definite, and of weeks' to months' duration. The third stage is the development of kyphosis, sometimes angular but usually more diffuse, with the return of some or all of the symptoms of the first stage or the appearance of new manifestations. In some cases the progressively increasing deformity of the vertebral column is the sole manifestation of the third stage.

The pathogenesis of Kuemmell's disease has not as yet been definitely

adhesions. The latter were divided; the roots, together with the cauda as a whole, receded to an approximately normal position. The surfaces of the roots of the cauda were moderately congested but there were no adhesions between them. The wound was closed in layers in the usual manner.

The prompt post-operative disappearance of pain and the rapid improvement in motor power, sensations and reflexes, with return to the normal in three weeks, are detailed elsewhere. The result was entirely satisfactory.

CASE II.—A man, thirty-nine years old, was admitted to Bellevue Hospital with the history that, eight months before, he fell with an elevator, striking his back sharply against the floor of the car. He was stunned, but did not lose consciousness. After remaining in bed for ten days, suffering severe pain in the upper dorsal spine, the patient could get about. Pain and sensitiveness gradually abated (so that he was able to return to his work), but did not disappear. Five weeks after the injury the patient noted a peculiar clumsiness of his legs, and he stumbled and fell while ascending a flight of stairs. Thereafter, the pain became much more severe, and complete incapacitation from work soon followed. Pain between the scapulæ, radiating down the arms, and occasional shooting pains in the legs have persisted up to the present. There have been frequent painful erections, occasionally attended by emissions. A deformity of the spine has not been noticed.

Upon physical examination it was evident that the patient was suffering considerable pain, exaggerated by the slightest efforts at moving the upper dorsal spine. The latter presented a very slight kyphosis with definitely abnormal though slight prominence and some lateral deviation of the spine of the fourth dorsal vertebra. The latter and the spines of the three vertebrae above it were tender upon pressure or percussion. The motor power in the upper and lower extremities was good except for marked weakness of the extensors of the left foot. The knee and ankle jerks were diminished. The evidences of a lesion of the lowest cervical or first dorsal segment of the cord were contracted right pupil with narrowing of the palpebral aperture and enophthalmos, and marked diminution in all sensations from a short distance below the clavicles downward, as well as along the inner aspects of both upper extremities. The diminution was greater over the right half of the body. It deepened to complete loss in scattered areas on the lower extremities. Röntgen examination showed the deviation of the fourth dorsal vertebra, but no evidence of fracture. Lumbar puncture revealed no abnormalities.

extremities. This cleared up rapidly, so that only weakness in the right leg remained after one month. Pain in the back and right leg was very severe in the beginning, clearing up almost completely within a few weeks. A deformity of the spine was not noticed. Six weeks after the injury the patient was able to walk well except for some difficulty in supporting his weight on the right leg (due to the injuries at the ankle?), and was almost completely free from pain. This relatively clear interval was of about three weeks' duration. At the end of that time pain in the lower back and pain and weakness of the right leg (to a much lesser degree of the left) gradually reappeared. Slight prominence of the spinous process of the third lumbar vertebra was noted. A plaster jacket was applied. Despite this, pain and weakness continued, became progressively worse for about two weeks, and then remained stationary. During a period of several weeks' close observation there was no evidence of improvement in pain or in power of the right leg. Pain was constant, sometimes dull and aching, occasionally sharp and shooting in character.

*Physical Examination.*—There was moderate kyphosis of the entire lumbar spine; the spinous process of the third lumbar vertebra was somewhat more prominent than normal and slightly deflected to the right. X-ray examination showed a finely comminuted fracture and moderate narrowing of the body of the third lumbar vertebra, with slight lateral rotation. All motions of the lumbar spine were restricted. The usual and the X-ray examination showed good healing of the fractures about the right ankle. The power of all the musculature of the right leg, except the quadriceps, was greatly reduced; the range of voluntary motion at the knee was fair, at the ankle slight, almost completely absent in the toes. There was some diminution in power, but fair range of motion, in the left lower extremity. Both feet, especially the right, were cold, and a zone of abnormal perspiration was present over the right foot and calf. Sensory loss was complete on the right side, over the foot and outer aspect of the calf (fourth and fifth lumbar and part of first sacral roots); on the left side over a much smaller area (chiefly fifth lumbar root). The knee and ankle jerks were greatly diminished on the right, absent on the left side.

A typical laminectomy was performed in August, 1916. The dura was found encroached upon by the laminae of the third lumbar vertebra; upon their removal the dural sac filled out. The subflaval ligament was much thickened. The epidural fat was not adherent except in a small patch on the right side at the third lumbar lamina. Opposite this point two roots of the cauda equina were closely held to the inner surface of the dura by thin

go with pyramidal tract involvement. Sensory loss was complete over both lower extremities, extending upwards to the level of the twelfth dorsal segment.

The Wassermann test of the lumbar puncture fluid was positive. In view of this and of the long-standing period of pressure upon the cord it was evident that operation could not offer the likelihood of great relief. However, prolonged antisyphilitic treatment had been of no avail, and, with the diagnosis of a Kuemmell's spine with compression of the cord, engrafted upon a (probably) luetic disease of the vertebræ, there was evidently no outlook for improvement by such treatment. Operation was therefore advised.

*Operation* (February, 1916).—The gibbus was exposed. The musculature on either side was pale and atrophic. The spines and laminæ of the eighth to twelfth dorsal vertebræ were removed; the ninth, tenth, and eleventh were very superficial, the eighth to twelfth unusually deep and obliquely placed. After removal of the adherent epidural fat, the exposed dural sac was found to be bent sharply backwards by the bodies of the affected vertebræ. The thickened, scar-like, tense dura was incised; the lips of the incision immediately separated and the cord presented in the gap. There were a number of fine adhesions between the cord and inner surface of dura that could be divided without bleeding. The cord was then found to be flattened to a surprisingly slight extent. Fascia was transplanted into the dural gap, as described in a previous section; the remainder of the wound was closed in layers. After operation there was a partial regain of bladder control for several months. The patient has stated frequently that her legs are less stiff than before operation, but this cannot be substantiated by physical examination. The dull, aching pain in the back has been permanently relieved and the patient says she is able to sit up better and more comfortably in her chair. Antisyphilitic treatment has been continued since the operation. The result of the operation has manifestly been practically no objective and some subjective improvement.

#### INDICATIONS FOR AND RESULTS OF OPERATION IN SOME POST-TRAUMATIC LESIONS OF THE SPINAL CORD OTHER THAN KUEMMELL'S DISEASE

The late effects of spinal injuries and the possibilities for their relief by operation have been emphasized recently by Elsberg. He described various lesions that were found at operation: Narrowing of the spinal canal by callus, pressure upon the cord by displaced fragments of bone or by one or more vertebral bodies, fracture of a transverse process producing root pain, rupture of the ligamenta subflava,

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*Operation* (January, 1917).—The spines and laminae of the sixth and seventh cervical and first dorsal vertebrae were removed in the usual way. The exposed dura was of whitish color and moderately thickened. There were several fine adhesions between the pia arachnoid and the inner surface of the dura on the right side opposite the situation of the sixth cervical lamina; they were divided with scissors. The exposed cord was somewhat smaller than the normal for this region, and was overspread by several engorged, rather tortuous vessels. The wound was closed in layers and a posterior wooden splint incorporated in the dressings.

There was prompt disappearance of pain after operation, much slower improvement in the area of disturbed sensation. The pain has never returned. At the present time, three months after operation, the patient is subjectively entirely well, and able to do heavy work. There is evidence of progressive sensory improvement, seen in the recession of the upper level of sensory disturbances and in the much slighter degree of diminution of sensations.

CASE III.—Female, aged fifty, had been in the Central and Neurological Hospital for six months without any change in symptoms. Four years before she slipped in the street, falling on her buttocks. She was unable to stand and suffered severe pain in the lower spine. The loss of power in the legs was of several days' duration; with rest in bed there was gradual improvement so that, at the end of five weeks, the patient was able to be up and about. Backache remained constant, however. About six months after the fall, prominence of the lower dorsal spine was first noticed. This increased progressively for several weeks and then became stationary. Not long after that pains in and weakness of the lower extremities began to develop, soon followed by frequency and difficult control of urination. One day, while walking about, the patient slipped and fell, and found she was unable to get up. Since that time (1913), there has been complete loss of power and marked stiffness in the lower extremities, complete incontinence of urine, and obstinate constipation.

*Physical Examination.*—There was a rather sharply angular gibbus involving the ninth, tenth, eleventh, and twelfth dorsal vertebrae, and a rounded kyphosis above and below it. The latter could be in part overcome by hyperextension, but the gibbus remains unaffected. Several X-ray pictures were unsatisfactory in the delineation of the vertebral bodies of this very obese patient. There was no voluntary power in the lower extremities; they were extremely spastic and presented the abnormal reflexes that

the back and the legs, appeared, and became progressively worse. The patient noticed gradually increasing "loss of feeling" and coldness in the lower extremities, especially over the anterior surfaces. Two months before admission difficulties in the urination began. By the time the patient came into the hospital there was almost complete loss of bladder control and of power in the legs.

The general condition was fairly good. When his body was supported on crutches the patient could drag his legs along the floor with great difficulty. There was slight tenderness of the spines of the sixth to ninth dorsal vertebræ, but no visible deformity. X-ray examination and Wassermann tests were negative. The lower extremities were exceedingly spastic; there was almost total loss of voluntary power in them. The evidences of pyramidal tract involvement were found in the bilateral patellar and ankle clonus, Babinski phenomenon, etc. Abdominal reflexes could not be elicited. Sensory disturbances began at the level of the ninth dorsal segment, gradually deepening until sensory loss was complete below the inguinal folds.

At operation in July, 1915, the spines and laminæ of the fifth, sixth, and seventh dorsal vertebræ were removed. No abnormalities in the bone were noted. The dura was of normal appearance except in a small area about the middle of the exposed portion, where it was more opaque. It was incised above and below this area, cerebrospinal fluid escaping in normal quantities. Stretching from the cord to the thickened part of the dura were thin bloodless adhesions. These were separated, releasing about two drachms of clear fluid indistinguishable from cerebrospinal fluid. The cord was slightly flattened and injected at the site of the localized collection of fluid, normal elsewhere. The dura was sutured, and the wound closed in layers.

Pains in the back and lower extremities disappeared shortly after operation and have not returned. There was steady improvement in the paraplegia and the sensory disturbances. Nine months after operation, the patient was able to walk several blocks with the aid of crutch or cane, bearing little weight on them. There was fair range of motion and power in both limbs at the hips, knees, and ankles (the left leg showing the greater improvement); their nutrition was also greatly improved. Spasticity was still great, however, and all the evidences of pyramidal tract involvement persisted. The abdominal reflexes had returned. Pain sensation was practically normal throughout. Tactile sense was disturbed only on the dorsum of the right foot. The temperature sense was impaired along the outer aspect of the right calf. Postural and deep muscle senses approximated the

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and fibrous bands constricting the cord. In the following small group of cases I wish to describe briefly some additional types of lesions the late results of injury. In presenting them the chief purpose in mind was to stress the following views:

A fair proportion of the patients that present themselves for operative relief from the lesions in question are not seriously incapacitated, do not suffer very greatly in many instances, and can live in some comfort for an indefinite number of years without operation. Manifestly there should be no mortality risk for such patients from the operation of laminectomy. Therefore, cases in which there is marked organic disease of the heart, kidneys, etc., and those in poor general physical condition, should be excluded except when the suffering from the spinal lesion is great, incapacity extreme, and when, in addition, the outlook for relief appears very bright. If the symptoms of cord injury have been of very prolonged duration, it may in general be said, I believe, that the chances for much improvement are slight (as in the two cases of post-traumatic sclerosis of the cord reported below), and it is particularly for this group of cases that the indications for operation must be most sharply drawn. The steps of the operation should be so carefully conducted and the post-operative care should be so scrupulous that the minimal possibility of making conditions worse by the laminectomy will exist. Finally, one can say, as a corollary to the foregoing remarks, that, in contrast to those desperate cases in which heroic or new operative measures have a proper place, the cases in question should not be subjected to untried procedures unless based upon logical and well demonstrated experimental evidence.

*CASE I.—Cystic subdural collection of fluid following injury to the dorsal spine. Laminectomy. Marked improvement.*<sup>1</sup> Male, fifty-two years old, admitted to the hospital in April, 1915, complained of pain in the back and the lower extremities, paraplegia, and incontinence of urine. Fifteen years before, he fell on his back from a height of some ten feet. He was in bed for almost a year, with both legs paralyzed, and rectal and bladder incontinence. Gradual improvement then began until the patient was finally able to get about a little with crutches. About three months before admission, marked weakness in both legs developed, more pronounced on the right side. For the first time pain, situated in

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<sup>1</sup> This and the succeeding two cases were studied in conjunction with Dr. Climenko, at the Central and Neurological Hospital, and an earlier and fuller report on them has been made (*The Hospital Bulletin of the Department of Public Charities*, January, 1917).



and muscle sense on the right side, very slight on the left. The sensory loss was complete on the right side up to the knee and over the posterior aspect of the thigh, incomplete over the anterior surface of the thigh. A hypalgesic and hypæsthetic zone surrounded the body at the level of the iliac crests; this was the only sensory change found on the left side. There was a vaguely defined hyperalgesic zone referable to the tenth to twelfth dorsal segments. There was some tenderness of the first lumbar spine, but no limitation in mobility and no deformity. X-ray examination and lumbar puncture were negative. The abdomen was relaxed, the upper right reflex was the only one that could be elicited.

*Operation* (December, 1915).—The twelfth dorsal, first and second lumbar spines and laminae were removed. The first lumbar was at a slightly deeper level than the others and rotated somewhat on its long axis, so that the hiatus often encountered between the twelfth dorsal and first lumbar spines was exaggerated. After removal of the twelfth dorsal and exposure of the dura, it was evident that the body of the first lumbar encroached upon and compressed the dura. The density of the laminae of the first lumbar was greater than that of the other vertebrae. The exposed dura appeared normal; its incision was followed by the escape of the usual quantities of cerebrospinal fluid. The inner surface of the dura was thickened opposite the abnormal lumbar vertebra; from this diseased area firm short adhesions extended to the adjacent cauda equina, sharply angulating and obscuring the roots. After division of the adhesions, the cauda equina, as a whole, receded to its normal position. The roots were then carefully separated from one another, this being carried only far enough to distinguish the individual trunks. The dura was sutured, and the remainder of the wound closed in layers.

The patient was entirely free from pain soon after operation; and there has been no recurrence of pain at any time. A pressure ulcer developed over the right great trochanter, healing slowly with appropriate treatment. There has been steady improvement in the sensory, much less in the motor, condition.

The following notes were made one year after operation: The patient can get around better than before operation, with the aid of her hip brace. She notices more power in the left hip and in all the motions of the left leg. There is complete control of bowel movements, and cathartics are very rarely required. She is entirely free from pain. The range of movements and the power in the right lower extremity are moderately improved. Postural sense is good at the right hip, defective at the knee, good at the ankle except in internal rotation, absent in the toes. On the left side abduction at the hip is excellent, adduction is poor,

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normal. The patient was able to return to a rather laborious occupation (automobile painter) eleven months after operation.

At the present time (one and one-half years after operation) there is still moderate spasticity of the legs, but excellent power and range of motion. Ankle clonus and Babinski persist. The abdominal reflexes are lively. Sensations are practically normal throughout. The patient remains free from pain.

CASE II.—*Adhesions and compression of the cauda equina following injury. Laminectomy. Improvement.* Female, thirty years old, married. Admitted to the hospital in September, 1913, complaining of weakness of the legs, more marked on the left side, severe pain in the back and in the right leg, and partial loss of bowel control. Eight years before the patient fell down a flight of stairs, striking her back. She remained in bed for several weeks, suffering severe pain in the back and legs; these symptoms cleared up in the course of several months and she felt quite well again, able to attend to her work. Four years before admission, the patient noticed that her legs, the left especially, were becoming weaker. Pain in them and in the back developed about the same time. These symptoms were rapidly progressive; within one month of their appearance the patient was unable to walk or even to stand. The left leg became quite "numb and dead," but free from pain. Difficulty in urination developed; the patient was removed to a hospital, where catheterization was required for several weeks. Voluntary control has been fairly good since that time. Obstinate constipation made its appearance, with very slight control when cathartics were administered. After these symptoms had persisted for about a half year, the right leg began to improve, so that the patient was finally able to get around a little with a brace supporting the left hip. However, the pains in the back and in the right leg became steadily worse, so that, during her stay in the hospital, the administration of morphine was frequently required, a grain or more ultimately being given every day or two.

The patient was in good general condition. Upon frequent occasions it was evident that she was suffering severe pain. With the hip brace she was able to walk short distances. There were no voluntary motions in the left lower extremity except some abduction at the hip. On the right side the motions were of fair range but of little power in the hip and knee, slight in the ankle, absent in the toes. Both extremities were very cold. There was considerable atrophy of both glutei (left greater than the right) and of the musculature of the extremities (left greater than the right), especially of the left quadriceps. The knee and ankle jerks were absent on both sides. There was profound loss of postural

the abdominal reflexes were present. Loss of sensation was complete over the lower extremities, and almost complete up to the level of the seventh cervical segment. Above this there was a wide zone of hyperæsthesia and hyperalgesia. Wassermann tests of the blood and spinal fluid and X-ray examination were negative. Prolonged antisyphilitic treatment was without effect.

*Operation* (July, 1915).—The fourth, fifth, sixth, and seventh cervical spines and laminæ were removed. They were of normal consistency and contour. The exposed dura looked normal; its incision was followed by the escape of the usual quantities of cerebrospinal fluid. The exposed cord was smaller than normal, flat, pale, and firm. Below, it was surrounded by thin adhesions extending from it to the under surface of the dura. These were separated. Near the upper angle of the wound the cord felt softer; it was aspirated here with negative result. A probe, passed in various directions, met no obstructions. The wound was closed in the usual manner.

Improvement in the gait began about six weeks after operation, was very slowly progressive for several months, and then ceased. The patient can now walk fair distances either unaided or with the use of a cane. The forward propulsion has disappeared. The power in the arms has improved slightly. No diminution in the spasticity of the lower extremities can be objectively determined, yet the patient has better control over their movements. One year after operation, the zone of hyperalgesia above the seventh cervical segment persisted, but sensation has almost completely returned below this. Movements of the head are much freer than before operation. One and one-half years after operation the motor condition is about the same, but sensations are normal throughout.

CASE IV.—*Post-traumatic sclerosis of the cervical cord. Laminectomy. Very slight improvement.* The operation was performed on this patient so recently (three months ago) that the very slight changes noted up to the present time may possibly be no index of what will happen in the future. The operative findings are so similar to those of the previous case, however, that much additional improvement is not looked for. A very brief report will therefore be made.

The patient, a fireman, two years ago fell a distance of 40 feet, landing on his back. He was in bed for several weeks thereafter, suffering pain in the back and legs. A few months later stiffness and weakness of the right arm and leg developed; gradually the left arm and leg became affected. There was no pain at any time, and no involvement of the bladder or rectum. At admission to Bellevue Hospital the patient could walk short

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flexion is almost *nil*; there is some flexion at the knee, accompanied by abduction with each attempt; occasionally there is a voluntary movement of the big toe. The loss of sensation on the left side is reduced to a small patch of hypæsthesia and hypalgæsia over the buttock. On the right side the area of sensory loss has shrunk and is less sharply defined; it is complete only below the knee. None of the reflexes in the lower extremities have returned, with one peculiar exception: Upon attempting to elicit the left ankle jerk there sometimes follows a delayed adduction and internal rotation of the leg.

CASE III.—*Post-traumatic sclerosis of the cervical cord. Laminectomy. Slight improvement.* Male, thirty-nine years old. Admitted to the hospital in July, 1913. In 1908, while working in an excavation, a heavy boulder struck the back of his head and neck a glancing blow. He did not become unconscious. There was some pain in the injured region for several weeks. Some time after the injury (perhaps four months) the patient noticed weakness in the shoulders, slowly extending to the arms and legs. This became progressively worse, so that he was unable to do any heavy work three years before admission. At the time of entrance into the hospital, the chief complaints were: Great difficulty and unsteadiness in walking, often falling when out of reach of support. A "rushing" gait (by which the patient means uncontrollable forward propulsion). Difficulty in the use of his arms, more marked on the left side. . . . During his stay in the hospital the patient's condition became steadily worse for about a year and a half, since which time no further changes have been noticed.

The general condition of the patient was good. His head was arched far forward, the dorsal spine kyphotic. In standing, his feet were kept widely separated, the body weight borne on the balls of the toes. The gait consisted of a number of uncertain, extremely spastic strides, followed by rapid, progressively increasing forward propulsion, until the patient brought up at some obstacle. There was some percussion tenderness of the very prominent seventh cervical vertebra; the other cervical spines could not be palpated, owing to the thick musculature and the arching of the neck. The upper extremities showed some atrophy of the musculature, especially in the shoulder-girdles and the upper arms. There was little power and marked spasticity in both, more marked on the left side. No reflexes were obtained. The lower extremities were far more spastic than the upper, but were not atrophic, and the reduction in power was not so great. The knee-jerks were exaggerated, the ankle-jerks diminished, a Babinski phenomenon was occasionally elicited on both sides. All

was performed. Thereafter the patient was entirely well and did heavy work until two weeks before admission, when weakness in the legs and inability to walk developed rather suddenly and the patient found that he was unable to urinate. Severe constricting pain about the chest and darting pains in both legs developed within 24 hours. The next day red and tender spots appeared in a narrow band about the upper chest. The patient became completely bed-ridden soon after. Regular catheterization was required. The bowel movements became very constipated, and finally impossible without enemata. Adhesive straps were applied over the skin lesions about the chest.

Examined upon admission the patient was found to be suffering considerable pain in the back and upper chest, greatly exaggerated upon ineffectual efforts to turn in bed. There were pressure ulcers over the sacrum and back. In a narrow strip about the upper chest were healing skin lesions referable to the second dorsal segment. The upper dorsal spine was rigidly held and the patient was unable to flex his head, apparently because of this muscular spasm. The fifth to ninth dorsal spinous processes were tender. Except for a small patch of preserved sensation to the left of the anus, all sensations were lost in both legs and as high as the level of the ninth dorsal segment to the left, the tenth dorsal segment on the right side. Both legs were absolutely immobile, and very spastic. The knee and ankle jerks were exaggerated, more so on the left side, and a left ankle clonus was obtained. The Babinski and other phenomena referable to pyramidal tract involvement were present. Abdominal and cremasteric reflexes were not obtained.

Two days after admission the level of lost sensations had extended upwards to the sixth and seventh dorsal segments. Within the next forty-eight hours the level of sensory loss had reached the third dorsal segment, ankle clonus (which had also developed on the right side) became very easily exhaustible. The latter, particularly, suggesting rapid progress of the lesion, led to the decision for prompt operation.

At no time during the period of observation was there any rise in temperature. Regular catheterization was necessary; bowels moved only with enemata. Blood counts were normal. Wassermann tests of the cerebrospinal fluid and blood were negative. The fluid withdrawn by lumbar puncture was clear, under normal pressure, and revealed no abnormalities other than a moderate increase in cells. Unusually clear X-ray pictures of the dorsal spine were absolutely negative.

In the diagnosis some interesting questions came up but these cannot be considered in this place. The existence of an epidural abscess was not suspected.

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distances with the aid of a cane. All four extremities were weak and exceeding spastic, with corresponding abnormal reflexes. Abdominal reflexes were obtained; the eye grounds were negative. Spinal fluid and blood tests were negative. Sensations were normal except for a zone of well defined although slight increase of all sensations in a thin band about the upper chest. X-ray examinations showed evidences of a diffuse osteoarthritis, most marked in the lower cervical region, and of old fracture in the lumbar region.

At operation, in the lower cervical region, the ligamenta subflava were thickened; there were some adhesions about the cord. The latter was smaller than normal, and presented a firm nodular thickening opposite the sixth cervical vertebra. Since operation, the zone of increased sensations has disappeared, the spasticity and weakness in the extremities have improved slightly so that the patient can get about somewhat better than before. The abnormal reflexes are as before operation, but not of so extreme a grade.

### PNEUMOCOCCUS EPIDURAL ABSCESS SECONDARY TO CHRONIC LOCALIZED OSTEOMYELITIS

The clinical picture of acute osteomyelitis of the spine is well known. At operations or at necropsies one or more localized collections of pus have been found in some cases. As the result of a diffuse infection of the bone, in other instances, purulent meningitis has been the final outcome. In most cases the ordinary acute osteomyelitis of the spine does not produce spinal cord symptoms; in exceptional ones such symptoms are referable to a widespread involvement of the spinal meninges. Tuberculosis, syphilis, and actinomycosis are the causes of the great majority of cases of chronic osteomyelitis of the vertebræ; any of them may result in the formation of an epidural abscess. In the few cases of chronic staphylo- or streptococcus abscess of the spine symptoms referable to the cord have not been described. The following case<sup>2</sup> is therefore reported not because it is thought to be a unique or bizarre condition, but as a clinical picture of a late effect of a bacterial infection.

Male, thirty-one years old, was admitted to the Har Moriah Hospital in December, 1915, suffering from total paraplegia and bladder and rectal incontinence. Four years before, a prolonged attack of pneumonia was followed in one month by a (pneumococcus?) osteomyelitis of the tibia, for which an extensive osteotomy

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<sup>2</sup> Studied in conjunction with Dr. Climenko.

after laminectomy even when there have been no preoperative disturbances in vesical function. The alteration in the reflexes has been presumed to be the result of changes in intradural pressure from the escape of large quantities of cerebrospinal fluid and the entrance of air into the subdural space at operation, for loss of the reflexes was never observed when the dura was left unopened. It is inferred that the post-operative retention of urine is ascribed to the same causes.

It is my belief that transient post-operative disappearance of reflexes and retention of urine are the results of mild injuries to the spinal cord at operation, from the necessary operative manipulations involved in the removal of tumors and the treatment of other lesions. This belief is based upon the following observations: In eight spinal cases operated upon by me at various levels only minimal manipulations of the cord were required for the conditions that were encountered. Some of these patients had exaggerated, others had diminished, ankle and knee jerks before operation; two had slight, the remainder had no vesical disturbances before operation. Examination of the reflexes was made twice daily for the first two or three days after operation. In none of the cases did the reflexes disappear, and in none was post-operative catheterization required.

The question is of practical as well as theoretical interest. For if, on the one hand, it is clearly recognized that lost reflexes and post-operative catheterization may be the justifiable sequelæ of removal of lesions in intimate association with the cord or cauda equina, of necessarily extensive exploration of the cord for small tumors, etc., it should also be recognized that these changes are not to be expected from the operation of laminectomy and incision of the dura in itself. Even a short period of post-operative catheterization is not a negligible matter; the possibility of bladder infection in patients suffering from spinal cord lesions is too well known to be dilated upon. Similarly, if temporarily lost reflexes are accepted as due to trauma to the cord or cauda equina, increasing efforts will be made, by care in avoiding a single unnecessary manipulation of these structures during operation, to reduce the number of instances in which the disappearance of reflexes and post-operative retention will be observed.

#### THE RETURN OF REFLEXES AND OF SENSATION AFTER CAUDA EQUINA INJURY

Some observers maintain that the loss of reflexes and of sensation, with corresponding loss of muscle tone and power, are permanent after injury to the cauda equina, and that, therefore, the sole indication for

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Operation was performed five days after admission to the hospital. The spines and laminae of the first, second, third, and fourth dorsal vertebrae were removed. The laminae of the second and third were somewhat thickened, and of ivory-like consistency. When those of the second dorsal were removed there escaped under considerable pressure about a half ounce of thick, greenish-yellow pus. The surface of the exposed dura was very deeply congested, evidently much thickened, and plastered over here and there by shaggy granulation tissue. The epidural fat was firmly adherent in several places and deeply injected throughout. A drain was inserted to the dura, and the muscles, aponeurosis, and skin closed in layers about it.

Examination of the pus yielded pneumococcus in pure culture. Microscopic examination of fragments of the laminae of the second dorsal vertebra showed that it was the seat of a chronic osteomyelitis; the epidural fat showed acute inflammation (Surgical Laboratory, Columbia College of Physicians and Surgeons).

Improvement set in rapidly immediately after operation. Pain disappeared. Within two days tactile and temperature sensations began to return in patches in the zone in which they had been completely lost, and very slight voluntary movements in the toes and ankles could be executed. Bladder control began to return in one week. The sensory improvement continued very much more rapidly than the motor. At the time of discharge from the hospital, five weeks after operation, sensations approximated the normal, the patient was entirely free from pain, bladder and rectal control were normal, and there was fair voluntary power in the lower extremities. The latter, however, remained very spastic, with all the evidences of pyramidal tract involvement, so that only very slow improvement can be expected. It is very possible that posterior root section for the relief of spasticity, or the operative treatment of a residual lesion about the cord, may be indicated.

### THE SIGNIFICANCE OF THE DISAPPEARANCE OF REFLEXES AND OF RETENTION OF URINE AFTER LAMINECTOMY

Attention was first called by Elsberg to the changes in the reflexes after spinal operations. He found that the knee jerks were often lost for from twelve hours to several days after operation and that the ankle jerks were often considerably diminished for several days. This loss or depression of the reflexes was noted even in cases in which greatly exaggerated reflexes existed before operation. Retention of urine for several days to several weeks has been commonly observed



of the picture of certain types of progressive spinal cord disease, otherwise one would not read or hear so often of lesions of the spinal cord "progressing to complete paraplegia and, finally, bed sores, complete incontinence of the sphincters, and death." That there is a pronounced tendency to the development of this complication in spinal cord affections, particularly in rapidly progressing myelitis, cannot be denied. But it is a far cry from this to, practically, the inclusion of bed sores as an integral part of the disease. It is true that they most often develop in those spinal cord conditions in which the outlook is absolutely hopeless. Perhaps this is the reason for the lack of application of the necessary measures for their prevention, and for a certain passivity upon their appearance. The practical importance of the prevention of pressure ulcers, as well as the necessity for careful treatment should they unfortunately develop, is evident when it is realized that sepsis from such lesions may be and not infrequently is the cause of death in those who otherwise might have become well, and that patients suffering from apparently hopeless lesions of the cord have been known to recover.

There is ample opportunity to investigate the question of the relation between bed sores and advanced cord lesions in the Central and Neurological Hospital. In every instance a decubitus could be directly ascribable, not to the disease from which the patient was suffering, but to the care given the patient. It is unnecessary to recapitulate the many precautions necessary for the avoidance of bed sores. It will suffice to say that the least let up in painstaking nursing and supervision may result in their appearance. A single impressive illustration may be mentioned: A bed-ridden patient at Bellevue Hospital, suffering from a fracture of the cervical spine, was operated upon by me and under observation thereafter for many weeks. During that period, with the adequate care given him, there was no trace of any decubitus. He was transferred to the Central and Neurological Hospital; in transit he spent several hours lying in one position on an unpadded stretcher carriage. Next day bed sores over the sacrum, back, both heels, and elbows had appeared and, despite careful protection, had begun to spread.

Perhaps the best evidence that decubitus ulcers are not primarily due to the spinal disease is seen in the fact that, unless very extensive, they frequently heal with proper nursing and treatment. There have been cases admitted, with numerous bed sores, to our division at Bellevue Hospital, in which these lesions have cleared up with adequate

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operation for such injuries is the relief of pain. The following case is presented as evidence that this view is not correct (for relatively recent cauda injuries at any rate) because it demonstrates the prompt return of reflexes, sensation, and muscle power, after an injury which did not sever the caudal roots.

The details of the history and operation are given in another place. The patient came under observation in Bellevue Hospital four months after an injury that resulted in prominence of the spine of the third lumbar vertebra. He complained of severe pain in the back and in the right leg from the knee down, less in the left leg. There was marked weakness of the muscles of the right leg, except the quadriceps, and some reduction in power at the ankle joint and toes of the left. The left knee and ankle jerks were absent, the right were considerably reduced. All sensations were lost on the right side over the dorsum of the foot and toes, and over part of the calf; that is, in an area corresponding chiefly to the fourth and fifth lumbar roots. There was a much more restricted zone of sensory loss on the left side, being chiefly limited to the dorsum of the foot.

The operative findings consisted essentially in compression of the dura and adhesions between some of the roots of the cauda and the inner surface of the dura. The compression was relieved and the adhesions separated.

Immediately after operation pain in the lower extremities disappeared, and did not return. Increase in muscular power in the legs began within forty-eight hours of the operation; at the end of eight days the power in flexion and extension at the knees and ankles was about the same on both sides and approximated the normal. Sensation likewise began to improve very soon after operation. At the end of eight days the anæsthetic zones were moderately hyperalgesic and hyperæsthetic. A slight left knee jerk was obtained for the first time three days after operation, the left ankle jerk appeared two days later; both reflexes steadily increased.

At the time of discharge from the hospital, three weeks after operation, there was excellent tone of the musculature and normal power of both lower extremities, and free range of motion at the knees, ankles, and toes. The knee and ankle jerks were normal on both sides. No abnormalities in sensation remained.

### THE SIGNIFICANCE OF "BED SORES"

There must be a generally prevalent view that the decubitus or pressure ulcer (commonly termed "bed sore") is an essential part

# THE TREATMENT OF WOUND INFECTION

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IN 1915 I invited attention in the *Lancet* to the results which I have obtained by treating desperate cases of infected railway wounds by four hourly irrigation with hot peroxide solution (5ii to litre) followed instantly by hot carbolic lotion (5ss to litre), and the application of hot perchloride of mercury fomentations (wrung dry).

A recent interesting summary by Capt. d'Este Emery, of his laboratory experiments with different antiseptics, encourages me to again ask surgeons in large hospitals to give the above a trial alongside similar cases treated by other methods.

It is, to say the least, an extraordinary coincidence that after decades of synthetic experiments, the first antiseptic (carbolic acid) used by our great pioneer, should retain its place, *facile princeps*, in the gamut of chemical disinfectants. Personally, I have given most antiseptics a trial during a continuous hospital experience of twenty-five years, and I confess that, for financial reasons, I was disappointed last year in the hope that eusol would prove equally efficacious, as the "peroxide carbolic" combination is a serious item of expenditure, when used on a large scale in a general hospital. I may mention the eusol was employed exactly as prescribed, and applied, by its Edinburgh advocates in severe cases, like compound fractures, in which streptococci and gas bacilli were in abundance, but it became very soon obvious, when treating similar cases alongside each other by the two methods, that "peroxide carbolic" was far superior and, moreover, it was frequently noted that, in cases treated with eusol, in which failure was very evident, a remarkable change occurred within three days after the "peroxide carbolic" was substituted, the granulations promptly assumed a healthy bright red appearance, the quantity of pus diminished, stench disappeared, with marked diminution in general toxic symptoms. Both were also tested side by side in cases of pelvic infection (*Bacillus coli*), and the results were identical to those obtained in bemuddled mangled wounds of limbs.

Since above was written, I had the opportunity of asking the Sister in charge of the department in which most of our grave septic cases are treated, her opinion as to the respective value of "peroxide car-

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care and despite the fact that the spinal affections from which the patients were suffering were irremediable.

Although many advances have been made in spinal surgery in recent years, the whole subject is as yet in an early stage of development. Many of its aspects are obscure and their solution by surgical treatment inadequate. The detached and rather fragmentary observations that have been made represent personal impressions held at the present time upon a few of these topics. They are presented chiefly with the idea that others will likewise state their views upon and experiences in such unsettled questions in spinal surgery, in the hope that some of these questions will be thereby clarified.

I hope Capt. d'Este Emery's report will tend to dispel another illusion. Many surgeons still advocate the use of strong mercurial lotion in septic wounds along with carbolic or peroxide or both, presumably with the idea that what one may miss the other may kill; if such is the basis of this practice, it strikes me as something akin to Léver's character at the Battle of Waterloo who slew friend and foe alike. I abandoned mercurial irrigation in the nineties, as I came to the conclusion that any substance which tends to form an albuminate in the tissues is a bad weapon to use against germs.

My clinical experience is quite in harmony with Capt. d'Este Emery's deduction that we should not employ any antiseptic that is easily quenchable, and I am of the opinion that the use of any chemical in any strength which may be deleterious to the vitality of the cells, or which may detract from the defensive properties of the serum, is only helping the enemy. Consequently, while I am a firm believer in the employment of "peroxide carbolic" lotions, I maintain that both should be used in a strength not sufficient to cause instant death to the invader, but sufficiently powerful to attenuate his virility or render the occupation of his trenches so uncomfortable, that, given a convenient loop-hole in the way of thorough drainage, he will clear out.

There seems to be a general consensus of opinion that free drainage is the primary factor in the treatment of these septic cases, and I wish to add that I am in complete accord with those who state that without a free exit for discharge antiseptics are hopeless, but I think it essential to emphasize the fact that the judicious use of an appropriate disinfectant is a most important life-saving secondary measure.

As to the best method of drainage, I know of none equal to that obtained by the liberal and well-applied use of a knife, and I strongly recommend that, when the general symptoms, as indicated by elevation of pulse and temperature, and coated tongue, are combined with a foul discharging wound, ether should be administered, tourniquet applied well above lesion, and a few, four to six incisions be made into parts in which fluctuation or boggiess is indicated on digital palpation, always carrying one or two such incisions into, or from, the original wound. The next move is to introduce the sense of sight into the business, retractors are applied, edges of wound drawn apart, and field mopped dry with gauze sponges. A careful inspection is then made of interior, while digital pressure is made all round exterior of wound; if any leaking into cavity is observed, a closed forceps or director is pushed into track, and secondary collection located, a direct incision is made into latter, and if there is no fear of anatomical sacri-

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bolic " and eusol. She replied, "I like the 'peroxide carbolic' best, it does not bring out eczema all round the wounds like eusol does," "the wounds have a better color with the carbolic."

Perhaps this independent testimony, of a most experienced nurse on whom the real brunt of the work falls, may be of interest.

Some ten years ago I commenced to use peroxide irrigation prior to employment of carbolic lotion, and again in a number of cases tested side by side, I found that the combination of both far exceeded that which was obtained by their separate use. Some cases of streptococcic tonsillitis happened to be in hospital at the time, and the same experiment was carried out with a similar result. We consider the joint use of both (gargle or spray every two hours) as specific in cases of common "sore throat." I regret that I am unable to give any scientific chemical reason why peroxide of hydrogen and carbolic acid form such a good antiseptic tandem.

It may be of interest if I mention that, during the past ten years, there have been thousands of irrigations made with carbolic acid lotion in the British Hospital, and in not a single instance has carboloria been observed.

It is only right to mention that we have found eusol a useful application for some indolent wounds, particularly bed sores.

As to hypertonic solution, with its hydraulic paraphernalia (*Lancet*, October 16, 1915), it suffices to mention that, in 1898, we gave salt solution an ample trial, and found it absolutely useless, not to mention the waste of valuable time, and the supervention of an epidemic of sepsis which I have not seen the like of before or since. I utterly fail to comprehend how anyone who has had any experience worthy of the term in the treatment of septic wounds can recommend such a procedure in the presence of virulent infection.

Some years ago I was induced by a paper of Sir William Watson Cheyne to give recent infected wounds one liberal saturation with pure carbolic acid. For the first few days after each application we found that there was an apparent lull in the infective process, but, invariably by the end of a week or ten days, the germs of destruction were in full swing, and I came to the conclusion that such treatment only deferred the issue, and consequently was bad practice.

In spite of the good results reported from the use of pastes, powders and creams I remain skeptical as to their value, as they have proved in my practice to be worse than useless, in that they become converted within a short time into adherent masses of infective filth, which are most difficult to eradicate.

can be safely pushed through the tissues, and when approaching the posterior subcutaneous area, expanded to the full (3 to 4 inches), thus indicating two definite distant points for one sweep of the knife. With the same scissors closed, as a blunt separator, the intervening tissues are promptly opened up to a diameter corresponding to the superficial incision.

(2) As to the method of irrigation suitable to cases in which there is always danger of contamination, particularly when a number have to be treated simultaneously in hospital, I strongly advocate the use of a one- or two-litre enamel jug, instead of irrigators or funnels with tubes and nozzles difficult to sterilize. I find that much more efficient lavage can be obtained by pouring the lotion in a steady flow from jug, and if the liquid issues from the counteropening in or about the same volume that it leaves the jug, one may rest assured that good drainage has been provided.

(3) It is most essential to apply a tourniquet in these cases, as otherwise the part becomes so obscured with blood and secretion that it is impossible to see what one is doing. I am certain that the omission of this simple detail has been responsible for the loss of many limbs. When the tourniquet is removed all spiriting vessels are seized with forceps and ligated with fine catgut; any oozing which may continue is checked by the subsequent irrigation with hot "peroxide carbolic." If the latter should not be successful, I pack the bleeding area firmly with large bibules soaked out in hot peroxide; these are removed in six to twenty-four hours by irrigation and gentle traction.

(4) The limb is always fixed on splint by separate bandages above and below lesion, so that subsequent irrigation can be carried out without removal of splint, and soiling of latter is prevented by the insertion of a piece of rubber tissue between it and affected portion of limb.

(5) When possible all serious cases should be kept permanently in the open air under a shelter roof, and if champagne is procurable, a really desperate case should not be denied a few bottles of it.

(6) As to the after-treatment I insist on the necessity for absolute rest until the wound is healed. There is no more certain method of obtaining a protracted convalescence than a premature taking off of splints and getting out of bed. And any attempt to sidetrack the natural factors which govern the natural repair of wounds should be studiously avoided. I have seen lamentable results follow ill-timed and ill-applied massage, and ruin follow in the wake of what is euphoniously styled "passive" movements.

## THE TREATMENT OF WOUND INFECTION

lege, there ought to be no hesitation in extending this incision in such a manner as to throw pocket sinus and original wound into one open chasm. I consider it imperative that both daylight and eyesight should be introduced into septic deposits similar to the standard treatment of osteomyelitis in long bones.

When infection is confined to the subcutaneous tissues, one need not worry about drainage, if the incision is of such a size as to eliminate the possibility of retention of discharge underneath overhanging edges. The existence of latter, particularly at angles of wound, is proof that the incision is inadequate, and this must be at once corrected.

The cardinal factor in this treatment is the conversion of a septic cavity or cavities into one large open sore, and, in nine cases out of ten, if this is properly done, and followed by four hourly irrigation with hot "peroxide carbolic" lotions and hot fomentations, with absolute rest on a splint, the onset of repair is only a matter of hours, or at most a few days. When feasible, submersion in warm peroxide lotion, once or twice daily, is a useful adjunct.

When one has, for example, an infected compound fracture to deal with, more extensive measures are necessary. It may be stated that, with rare exceptions, when the seat of infection is situated beneath muscles or between muscular planes, drainage cannot be properly effected without the aid of gravity, and, in order to obtain this, a large counterincision must be made at the most dependent level, so that the discharge may fall out of the wound, something similar to what would happen if the bottom was knocked out of a pail of water. The object in view is to form an adit sufficiently large to look through, and which will insure instant automatic evacuation of infective secretion, as it is puerile to expect leucocytes and serum to put up any defence if they are allowed to be drowned in virulent re infective material.

As there is always a tendency for the edges of tunnel wounds, irrespective of size, to adhere within forty-eight hours, I always pass two large rubber drainage tubes right through such wounds to act as props, in order to secure the subsequent patency of opening; these are changed on the second day, and, if the general and local conditions are satisfactory, the case is left in charge of the Sister, who continues four hourly irrigation and fomentations until the whole wound is free from pus, and covered with healthy granulations.

I now wish to invite attention to some details in this method of treatment:

(1) As a useful guide to a good counterincision, I have found a closed large straight blunt scissors a very handy weapon. which



I am cognizant of the fact that this method of treatment of wound infection has, like many other things, its compensatory defect, in the way of large wounds which take a long time to heal, but this is of small import compared to the gain—a limb or life saved. Recently it has been suggested that, when such wounds are in a suitable aseptic state, secondary sutures should be employed, but there is always the difficulty of determining the opportune moment for such intervention in cases that have been once septic. I have on many occasions attempted to hasten matters in this way, and while I have had some highly satisfactory results, I must admit, that I have had more disappointing ones, an experience which justifies the inference that, in many wounds which appear microscopically free of infection, such a simple procedure as the insertion of a few sutures, under strict antiseptic precautions, evokes such an intense septic explosion that it is logical to assume that militant germs, phoenix like, are gifted with the faculty of resurrection from their own ashes. While I do not condemn the attempt to close such wounds by secondary suture, I think it right to add a word of warning, that the result of same may turn out to be the reverse of what one might reasonably expect.

As to the treatment of post-septic wounds, healing up by some intention, my favorite applications are "Lotio Rubri," Ungt. Boracic. (grs. x to ʒi), hot lead or boracic fomentations (ʒi of each to litre) applied three times a day, plus absolute rest on a splint until the wound is healed. This I combine with plenty of fresh air, and a glass or two of stout, beer, or good wine with meals.

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I wish also to state that I have no use for any kind of gauze drainage or packing while the septic battle is raging, and I have not the slightest doubt that the best results can be obtained by those who keep the ring clear of all foreign bodies, irrespective of their impregnation with emulsions or balsams.

So far little mention has been made of tubes for the purpose of drainage, the reason being that long experience has proved to me that tubes do very little draining, but form useful props to keep wounds patent for the evacuation of fluid, and also serve to establish a channel for drainage subsequent to their removal. In abdominal work I usually omit the tube on the second or third morning. This practice is the result of what I have over and over again witnessed—a considerable rush of pent-up liquid the moment the tube is removed; in other words, tubes, like gauze saturated with secretion, may act as corks, as well as irritating—if not infective—foreign bodies. But, as it is incumbent to provide some outlet in septic cases, one has to choose between the lesser of evils, and insert some kind of prop so as to prevent the wound from closing. I think it advisable to change the tube or tubes within forty-eight hours, and substitute a new one once or twice daily until the sixth day, when it should be dispensed with altogether. And in septic infection, other than abdominal, I strongly recommend lavage with “peroxide carbolic,” each time a tube is taken out, and before a fresh one is inserted, so as to remove the secretion and débris which always hang about the track.

In order to obviate any misunderstanding I wish to mention that I rarely employ irrigation during operation in septic abdominal cases, as I am possibly obsessed with the dread of diffusing septic elements into the recesses of the abdomen. Instead I rely on thorough mopping up with dry bibules, and generally insert two large tubes right down to seat of infection. I think, in all such cases, that it is most essential to provide ample room around tube for free exit of secretion. The long diameter of opening left in parietal wall should be at least three times the diameter of the ordinary “gas pipe” tube employed. This may appear an exaggerated precaution at time of operation, but I am prepared to make a bet that it will not appear one bit excessive when wound is dressed, say six hours later. When the prop is removed on third morning, the factors which govern natural defence have encompassed the infected field with an adhesive barrier, which safely admits of gentle irrigation of cavity with peroxide carbolic lotions if such be considered necessary. Tight-fitting tubes in a septic abdomen are, in my opinion, a menace to the existence of the patient.

typhoid, possible appendicitis, tubercular meningitis and a peritonitis secondary to the primary throat condition were all considered, but a definite diagnosis could not be made.

She was treated symptomatically, the nausea and vomiting gradually becoming less, headaches and iliac tenderness diminishing. The constipation remained obstinate, cathartics were almost without effect and enemata practically so. Small unsatisfactory movements could be obtained by a combination of both. The abdomen, however, became softer and less scaphoid. During this time there was an intermittent inability to urinate and a catheter had to be used.

Blood counts made on the third and seventh days showed a diminished leucocyte count, a smaller percentage of polymorphonuclears and an increase of large and small lymphocytes, up to 44 per cent. An examination of the eye grounds was negative. Her temperature varied from  $97.8^{\circ}$  to  $100.4^{\circ}$  and her pulse from 90 to 110, both becoming normal on the ninth day.

She was allowed to return home to be under the care of her physician on September 19, having been in the hospital under observation twenty-five days. But eight days later she was readmitted because of the persistent constipation and return of severe nausea.

An exploratory laparotomy was offered and readily accepted. A right rectus incision was made and the transverse and ascending colon were found practically in the pelvis but otherwise normal. A calcified gland was removed from the mesentery of the ascending colon, on which the pathologist subsequently reported that it was entirely degenerated, that no structure was visible and that it was possibly tubercular. The cæcum and first portion of the ascending colon were surrounded by a pericolic membrane but were not in any sense bound down by it. The appendix was long, thin, to the outer side of the cæcum and covered by the membrane. The appendix was removed together with the right ovary which was completely cystic.

A particularly careful examination was made of all the abdominal viscera with negative findings in all except the small intestine. This was everywhere pale, firmly contracted and ribbon-like and seemed to occupy but the central portion of the abdomen. Although the small intestine was firmly contracted the slightest traumatism with finger or instrument would cause a still further marked contraction for a distance of about six or eight inches. There was nothing even suggestive of obstruction in any part of either large or small bowel, the large bowel being about normal in size.

She made a perfectly satisfactory post-operative recovery, ex-

## ANGIONEUROTIC ŒDEMA WITH VISCERAL CRISES\*

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ANGIONEUROTIC œdema, except in its manifestation as hives, is not of particularly frequent occurrence and certainly, if we can judge by the lack of literature and brevity of text-book articles, its visceral manifestations are but little known and understood. It is for this reason that the following case is considered worthy of report.

A young woman, twenty-one years old, single, a college student, was referred to me on August 25, 1916, by Dr. Becker, complaining of nausea, vomiting, obstinate constipation, severe headache and pain and tenderness in the right iliac region. Her illness began seven days before with a sore throat—the vomiting, constipation, headache and abdominal symptoms quickly supervened and persisted. Her abdomen was markedly retracted and quite rigid, with tenderness in the right iliac fossa and pain radiating to the epigastrium. No masses could be discovered, her spleen was not palpable and her liver was not enlarged. Over the upper portion of her abdomen were some rose spots suggestive of but not typical of typhoid. Her temperature was 98.8°, pulse 108 and respiration 26. Diastolic blood-pressure was 95 and systolic 120. The blood count was as follows: Leucocytes, 11,200; polymorphonuclears, 68 per cent.; transitionals, 1 per cent.; small lymphocytes, 26 per cent.; large lymphocytes, 3 per cent.; eosinophiles, 2 per cent. No plasmodia could be found and a Widal in a dilution of 1 to 40 was negative as was also a Von Pirquet. She had always been highly neurotic, subject to marked superficial vasomotor disturbances—as Dr. Becker aptly expressed it, you could write your name on her skin with your finger tip. For several years she had suffered with intermittent attacks of pain and tenderness in the right half of the abdomen.

Here then was a patient who had been ill a week with obstinate vomiting and constipation, a markedly rigid and retracted abdomen with tenderness in the right iliac region, severe headaches later developing quite a pronounced photophobia. Her mental condition was rather apathetic, but she could not sleep. Her temperature was 98.8° and pulse 108. Diagnoses of tubercular peritonitis,

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\* Read before the Brooklyn Surgical Society, February 1, 1917.

At the time of the patient's first admission to the hospital and while we were endeavoring to make a diagnosis, the possibility of an intestinal crisis due to angioneurotic oedema was considered, but unfortunately we did not look up the literature as thoroughly as has been done since, and only being familiar with the short and unsatisfactory text-book descriptions dismissed the possibility from mind.

Subsequently all available literature was reviewed and we became convinced that it was a case of angioneurotic oedema and obtained the following additional information from her.

Her maternal grandmother died of tuberculosis. Her mother is a most neurotic individual with periods of great mental depression. The remainder of the family history is negative. The patient has never been strong and robust and from the age of three until fourteen she suffered with asthma. She states that until she went to college she never had a sick stomach, but about two years ago she had an attack of vomiting which lasted one week, was then well for one week and was then seized with a violent attack of abdominal colic. The pain was at first high and it was thought that she had pleurisy, but later it moved to the right iliac region. This illness was preceded by a sore throat lasting but a few hours. She has had three such attacks, though the abdominal pain was never so severe as in the first, always preceded by a sore throat of very short duration. In one attack her throat suddenly became very sore at 7 P.M. and she could not swallow, and at 4 A.M., nine hours later, her throat was perfectly well, but she began to suffer with severe abdominal pain. In between her attacks she has had practically constant abdominal discomfort shifting in character. In the intervals her bowels have been regular. She has never vomited any blood nor passed any by bowel. Her abdominal pain is usually worse at night and an acute exacerbation will usually begin about 10 P.M. Crispin states that the nocturnal exacerbations are frequent, and in one instance he observed a suggestion of regularity in the return of pain about the same time each night. She gives a history of one attack of bronchorrhœa lasting one day; a symptom which Halstead emphasized. She has never had the typical swellings but states that at times her lips have been red and swollen "as though she were about to have a cold," and that she frequently has red blotches on her neck and arms which burn but are not elevated nor swollen.

Following the operation she gained considerably in weight, but her symptoms of nausea and vomiting returned. Constipation again became troublesome until placed on hyoscyamine and camphor

cept for the slightest kind of a superficial infection due to a small infolding of the skin. Nausea and vomiting were no more than usual following anæsthesia. She did, however, have a temperature which reached  $101.6^{\circ}$ , but which became practically normal before she was discharged on October 18th, twenty-one days after admission. Constipation remained persistent until she was placed on hyoscyamine and comphor monobromate which resulted in free satisfactory bowel movements. The use of antispasmodic medication suggested itself to us by the contracted and spasmodic condition of the small intestine as seen at operation, and the results certainly justified its use.

A blood count made seventeen days after operation was as follows: Red blood-cells, 3,900,000; leucocytes, 20,000; hæmoglobin, 75 per cent.; polymorphonuclears, 77 per cent.; large mononuclears, 0 per cent.; transitionals, 1 per cent.; small lymphocytes, 17 per cent.; large lymphocytes, 4 per cent.; eosinophiles, 1 per cent.

Shortly after her return home her temperature became  $102.4^{\circ}$ , she complained of considerable pain in her right iliac region and a tender doughy mass could be palpated here. The temperature gradually dropped to normal and the mass disappeared.

I was out of town and did not see her at this time, but cannot believe that the abdominal mass was inflammatory. The operation was a perfectly simple one with absolutely no soiling, and it is difficult to comprehend an abscess developing under these circumstances over three weeks after operation and then entirely subsiding. We believe that it was probably an œdema of the bowel similar in character to the cases described by Crispin in an article entitled "The Visceral Crises of Angioneurotic Œdema" (Collected Papers of the Mayo Clinic, 1915, page 823), in which he states "there is another type probably resulting from the same primary cause that is occasionally mistaken for appendicitis or appendiceal abscess in which the onset and disappearance of pain are more gradual. A swelling often appears in the lower right abdomen, which suggests appendiceal abscess. There may be increased temperature; the symptoms, usually of short duration, are out of proportion to the patient's general condition, which is fairly good. In operating on these patients a brawny induration, often of the whole cæcum and appendix, thick-walled and somewhat hard, is found."

Riggs (*Northwest Medicine*, May, 1915) also mentions a case in a male, twenty-four years old, complaining of epigastric pain, temperature  $101^{\circ}$  and a doughy mass at McBurney's point, and he quotes Sutherland, emphasizing the fact that the site of election for this form of intestinal hemorrhage, that is, a hemorrhagic condition of the bowel wall, is in the ileocæcal region.

## STAB WOUND OF THE DEEP EPIGASTRIC ARTERY\*

WITH COMMENTS UPON THE SURGERY OF THAT VESSEL

BY PENN G. SKILLERN, JR., M.D.

OF PHILADELPHIA

J. B., schoolgirl, white, fifteen years of age, was admitted to the Polyclinic Hospital on October 31, 1916, at 9.40 P.M., and discharged, cured, on November 26th.

*History of Present Injury.*—During a Hallowe'en frolic at 9.30 on the evening of admission—ten minutes before reaching hospital—the patient was stabbed in the abdomen by a fifteen-year-old boy, who wielded a new penknife with a blade  $1\frac{1}{2}$  inches by  $\frac{3}{8}$  inch. The patient experienced pain only when the knife was withdrawn.

*Physical examination* reveals an incised wound of the abdominal wall which involves the middle of the left rectus muscle just below the level of the navel. The direction of the wound is oblique, and the length is  $1\frac{1}{4}$  inches. There is no protrusion of the omentum or of a viscus. On admission there was no undue amount of external bleeding from the wound, but after etherization was begun a smart amount of blood began to well up from the wound. The patient was not greatly shocked and there was no unusual abdominal rigidity previous to operation.

*Operation.*<sup>1</sup>—Ether anæsthesia. The stomach was washed out, and many masticated nuts were removed. A vertical incision, 4 inches in length, was made through the middle of the left rectus muscle, incorporating the stab wound. There was active bleeding from the stab wound, and the tissues bordering upon the latter were suffused with blood. On retracting the outer portion of the rectus muscle and inspecting its posterior surface the deep epigastric artery was found to have been severed in the stab wound and was still bleeding, though with diminished force. Both ends of the artery, together with its accompanying vein, were ligated. On incising the peritoneum blood-clots welled up, followed by the thin omentum. Evisceration of the movable intestines was rapidly performed, the coils being covered by hot, moist compresses. The blood-clots led down into the pelvic cavity, from which at

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\* Read before the Philadelphia Academy of Surgery, January 8, 1917.

<sup>1</sup> By Dr. Skillern in the absence of Professor Morris Booth Miller, upon whose service the patient was admitted.

monobromate and it was found that by increasing the dose a diarrhoea could be produced.

The text-books are so sterile on this subject that the following extracts from the literature seem worth while.

In Osler's article, "The Surgical Importance of the Visceral Crises of the Erythema Group of Skin Diseases" (*American Journal of Medical Sciences*, May, 1904), he states, "It is also to be borne in mind that recurring colic may be for many years the sole feature of this remarkable disease (angioneurotic œdema) as in cases Nos. 17 and 27 of my series, in which the obscurity of the attacks of colic was not cleared up until the final appearance of the skin lesions."

He further states, "the possibility of mistaking these visceral crises for appendicitis or intussusception or obstruction of the bowel and handing the patient over to the surgeon for operation is by no means remote," and still further (*American Journal of Medical Sciences*, January, 1904), "One of the most constant features of this whole group, occurring in twenty-five of the cases, is the recurring attacks of colic, sometimes with vomiting, sometimes with diarrhoea, occasionally with the passage of blood."

Crispin confirms Osler's observations and states "these visceral or gastro-intestinal crises may be so severe at first sight as to cause concern, and they may be without external clues in the nature of lesions of the skin."

Riggs cites several interesting examples of this condition: Two boys both with temperatures reaching 103 and remaining up for several days following operation. In one "not only were no purpuric spots present but no angioneurotic nor urticarial symptoms were noted."

The abdominal pain complained of in these cases has been ascribed to a distention or stretching of the bowel wall due to the œdema, but as there was no œdema present in our case we believe that the symptoms were due to spasm, a pre-œdematous stage of angioneurotic œdema.

Following Crispin's article in the *Collected Papers of the Mayo Clinic*, 1915, is quite a complete bibliography of this most interesting condition.





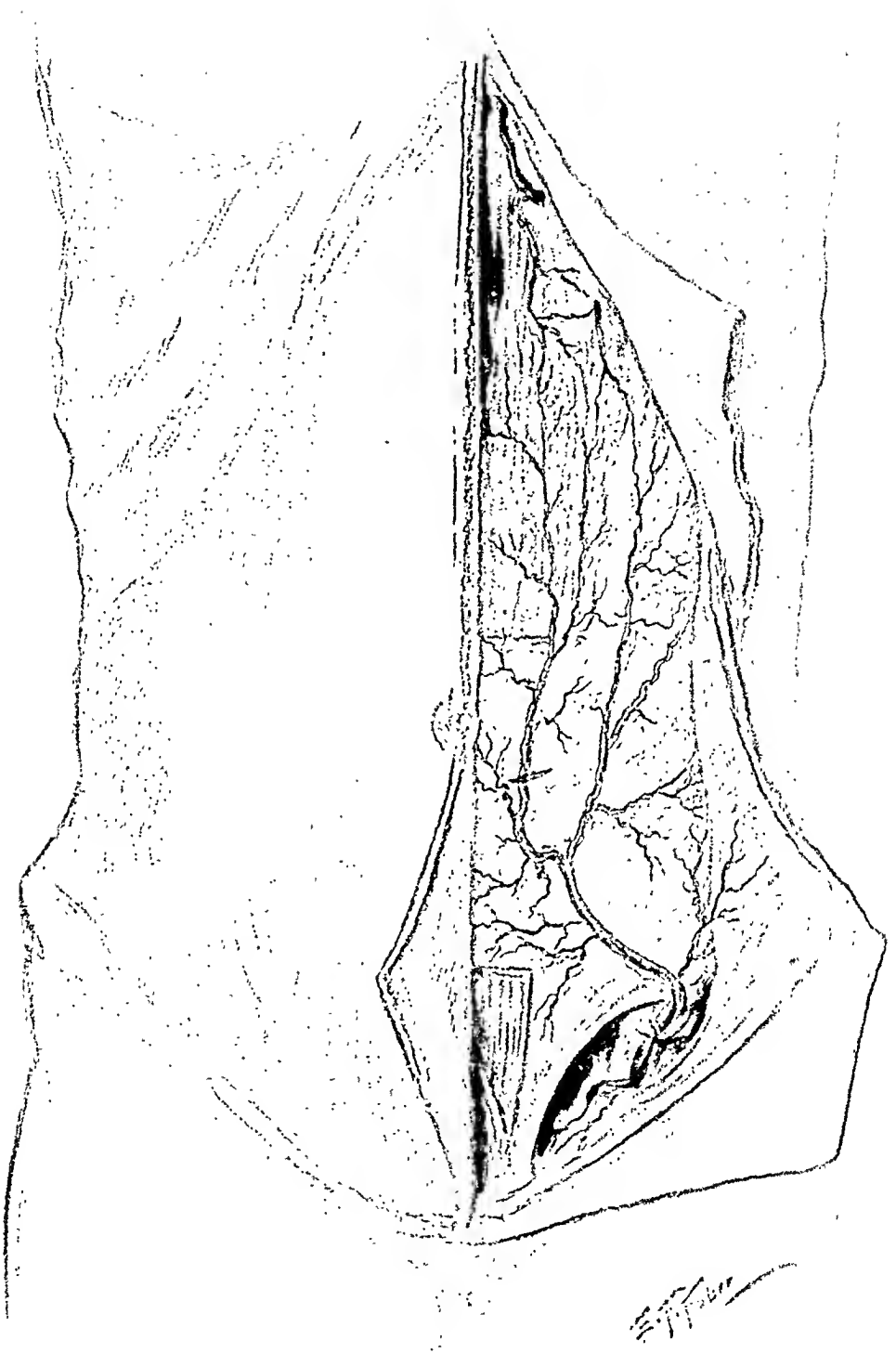


FIG. 1.—Sketch from dissection by author of deep epigastric artery, showing its course, division into two trunks, branches of distribution and anastomoses. Below and to left of navel is shown the portion divided by the stab wound. The site of election for the application of a ligature is shown close to the origin of the vessel from the external iliac. The anomalous obturator vessel is shown better in Fig. 2.

the wound and acts as a natural hæmostatic packing. Such a case is reported by Hunter.<sup>4</sup>

W. S., white man, age —, in a fight a few hours ago, was stabbed with a short dirk in the abdomen. The knife entered about  $1\frac{1}{4}$  inches to the left of the median line, a little below the level of the anterior superior process of the ilium. Cutting inward and upward diagonally across the fibres of the rectus muscle, the knife divided a branch of the deep epigastric artery and entered the abdominal cavity. The withdrawal of the knife was followed by considerable hemorrhage, but this was soon arrested by a piece of the omentum as large as the hand, being forced through the wound during the efforts at vomiting and coughing, which immediately succeeded the injury.

In our case the appearance of the usual signs upon which exploratory cœliotomy for perforating wounds is based was anticipated by immediate operation, which was based solely upon the surgical axiom that, given a penetrating incised, lacerated or punctured wound—especially in the region of important vessels, nerves, tendons, or viscera—the extent of damage done by the vulnerating agent can be accurately determined by exploratory operation alone. *In this case it was just as important to find out what the knife did not do, as it was to find out what it did do.* Thus, when the patient was first seen all that could be learned by inspection was that there was a penetrating wound which had divided the skin over the known course of the deep epigastric vessels; in order to inspect further we had to explore, and by exploring we found the deep epigastric vessels divided, the peritoneum opened, and hemorrhage taking place from the vessels through the rent in the peritoneum into the pelvic cavity. As to what the knife did not do we assured ourselves that it did not make a gross wound in the bowel, nor injure the vessels of the omentum or mesentery. Without exploration the true situation would have been but a matter of conjecture.

In the Medical and Surgical History of the War of the Rebellion, Part II, surgical volume ii, p. 9, Otis reports seven cases of secondary hemorrhage from gunshot wound of the deep epigastric vessels, of which five cases were fatal. He states, "Here, as in the management of bleeding from the wounded internal mammary and intercostal arteries, timid, inefficient, temporizing treatment appears to have been followed by lamentable loss of life. *The instances to be cited teach emphatically that wounds of the epigastric, circumflex, mammary, and lumbar arteries are not to be regarded as trivial, but demand the rigorous*

<sup>4</sup> Maryland and Virg. M. J., Richmond, 1860, xv, 136.

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least one pint of blood-clots was removed. Careful inspection of iliac arteries and veins and of vessels of mesentery and meso-sigmoid and omentum revealed no other source of hemorrhage; nor was gross injury to any viscus found; there were no fecal contents free in the abdominal cavity, nor was the gut collapsed at any point. Masticated nuts were felt along the course of the bowel and in the appendix. The eviscerated intestines were replaced. One pint of normal saline solution was placed and left in the abdomen. The wound was closed by tier sutures of chronic gut. No drainage was employed. Intravenous saline of 750 c.c. was given on the table.

With the exception of superficial infection of the stab wound convalescence was uninterrupted. On the sixth day after operation the patient passed a few old blood clots *per anum*. This suggested that the angular point of the penknife (Fig. 1) had inflicted a small incised wound in the wall of a coil of gut. This wound, however, must have been immediately closed by contraction of the muscular wall of the bowel aided by prolapse of the mucosa into the mural wound, for at the time of operation there were no signs of an unsealed perforation of the intestine.

The salient feature in this case was the concealed hemorrhage. Writing upon punctured wounds of the arteries of the abdominal wall Lidell<sup>2</sup> says: "When these arteries are opened by wounds which penetrate the abdominal cavity, and the apertures in the integuments are closed without first securing the wounded vessels, the blood may flow inwardly and collect in great quantity in that cavity; *this concealed hemorrhage may be so abundant as to prove fatal.*" That such a hemorrhage may prove rapidly fatal is shown in a case of perforation of the deep epigastric artery in the course of paracentesis for ascites.<sup>3</sup> In this case puncture was made at a point equidistant from the navel and anterior superior iliac spine. On withdrawing the trochar a small drop of blood appeared at the puncture orifice. Two and one-half hours after puncture the patient began to manifest signs of internal hemorrhage and died shortly afterward while waiting for a priest. At necropsy a large quantity of red and almost pure blood escaped from the abdomen—*about 4 litres. A great clot occupied the left iliac fossa.* The epigastric artery itself, and not one of its branches, was injured. Our patient was upon the operating table one hour after the stabbing. Concealed hemorrhage from such a wound may be checked and even prevented when, by a fortuitous circumstance, the omentum prolapses into

<sup>2</sup> Ashhurst's "International Encyclopædia of Surgery," 1883, iii, 129.

<sup>3</sup> Merle: Bull. et mém. de la Soc. anat. de Paris, 1907, 6 S, 9, 522.

the crural ring to anastomose with the pubic branch of the obturator artery. Sometimes when the obturator branch of the internal iliac artery is absent, the pubic branch of the deep epigastric artery enlarges and becomes the obturator artery (Fig. 2), which descends to the obturator foramen, according to observations made by Jastschinski, along the outer border of the crural ring in 60 per cent. of the cases, this arrangement being more frequent in females; across the ring in about 22.5 per cent. of cases, again more frequent in females; and along the free edge of Gimbernat's ligament in only 17.5 per cent. of cases, this being more common in males. In the last two instances the artery may be injured in the operation for the relief of a strangulated femoral hernia.

The deep epigastric artery may be mapped out by drawing a line from a point midway between the anterior superior iliac spine and the symphysis pubis towards the navel. According to the dissection made by the writer (Fig. 1) the trunk of the deep epigastric artery, on reaching the outer border of the rectus, divides into two large branches, a mesial, which continues the course of the trunk upward through the rectus muscle, and a lateral, which bends laterally as it inclines upward, to supply the flat muscles of the flank. Both are shown in the cut anastomosing with the superior epigastric and lower intercostals.

The deep epigastric artery is but one of a series of what we shall term parietal vessels of the trunk, the others being the internal mammary with its perforating branches, the intercostals, the lumbar, the ilio-lumbar, the circumflex iliacs, and the superficial epigastric. Practically all these vessels are of surgical significance, the first in the operation of removal of the breast, the second in punctured wounds of the thorax and rib resection, and the last in herniotomy. All must be dealt with with wholesome respect, for practically all when opened and not tied are capable of terminating life by hemorrhage.

The deep epigastric artery is larger than it is commonly conceived to be. In the specimen from which the sketch (Fig. 1) was made the trunk was the size of the ulnar. It is accompanied by a single vein, although in some cases there are two veins. When the artery has been injured the hemorrhage may be checked by packing with iodoform gauze or by ligation. It is very easy to ligate the vessel close to its origin, as the writer found by investigations upon a series of cadavers. All that is necessary is to make a  $\frac{3}{4}$ -inch incision above and parallel with Poupart's ligament, and midway between the anterior superior iliac spine and the symphysis pubis. Cutting down through skin, both layers of superficial fascia (ligating the superficial epigastric), deep fascia and external oblique aponeurosis, the cremaster and arching fibres of the internal

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*application of the rules for the management of wounded arteries, the exposure of the bleeding point, and a proximal and a distal ligature."*

Had operative interference been delayed in this case the concealed nature of the hemorrhage would, of course, have been indicated by pallor, by cold, clammy sweats, and by feeble pulse, along with sighing, thirst and restlessness. The accumulating blood gravitating to the pelvic cavity would have produced sensible enlargement of the hypogastric region, soft at first, and solid afterwards, and would have been detected by rectal palpation.

Boyer<sup>5</sup> speaks forcibly of the importance of ligation for hemorrhage from these wounds, and gives particulars of an instructive case of wound of the deep epigastric artery, that proved fatal, in which this measure had been neglected. Guthrie<sup>6</sup> several times saw this artery tied with success. In the case of a Portuguese soldier stabbed in the belly with a sabre, there was profuse hemorrhage from a small wound made by the point of the weapon. This wound Guthrie enlarged until the wounded but undivided artery became visible; upon this two ligatures were placed, and the external wound was sewed up. The man recovered.

### SURGERY OF THE DEEP EPIGASTRIC ARTERY

According to Cunningham's description, the deep epigastric artery (Fig. 1) arises immediately above Poupart's ligament from the front of the external iliac. Curving forward from its origin it lies in the extra-peritoneal fat, it turns round the lower border of the peritoneal sac, and runs upward and inward along the inner side of the internal abdominal ring and along the outer border of Hesselbach's triangle; it then pierces the transversalis fascia, passes over the semilunar fold of Douglas, and enters the sheath of the rectus abdominis. For a short distance it ascends behind the rectus, but it soon penetrates the substances of the muscle, and breaks up into branches which anastomose with terminal offsets of the superior epigastric branch of the internal mammary artery and with the lower intercostal arteries. At the internal abdominal ring in the male the vas deferens, the spermatic vessels, and the genital branch of the genitocrural nerve hook round the front and outer side of the artery, the vas deferens turning inward behind it; whilst in the female the round ligament of the uterus and the genital branch of the genitocrural nerve occupy the corresponding positions. The branches are muscular, cutaneous, cremasteric and pubic. The *pubic branch* descends on the outer or the inner side of or across

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<sup>5</sup> Cited by Lidell, *loc. cit.*

<sup>6</sup> Commentaries, etc., p. 510. Am. ed.





FIG 2.—Sketch from same cadaver as Fig. 1. The obturator is seen arising anomalously from the deep epigastric and descending in dangerous relation with crural ring to obturator foramen. The application of a ligature to this vessel at its origin is shown.



# RETROPERITONEAL HERNIA INTO THE DUODENAL FOSSÆ

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THE case reported in this paper is unusual enough to justify putting it on record. Its study adds nothing in particular to our knowledge of the diagnosis or treatment of a rare and oftentimes very serious condition. Its report on the contrary is intended to distract our attention for the moment from the usual intra-abdominal lesions, the diagnosis and treatment of which is well standardized, and to act as a reminder that we as surgeons should be prepared to recognize and deal with the unusual conditions which any of us may encounter.

Until a few years ago my knowledge of retroperitoneal hernia was most hazy; at that time the tragic death of a young medical student from this cause brought the subject very vividly to my attention, and had it not been for the experience gained from this case the outcome of the case with which the present paper deals might have been different.

The history of the case is as follows:

P. P., man, aged thirty, had enjoyed the best of health till three years ago. He then began to have abdominal attacks which were diagnosed appendicitis by several competent men. These attacks occurred every two to eight weeks and lasted two to five days. They were characterized by colicky pains in the epigastrium which usually became localized in the right iliac fossa; nausea which was only occasionally accompanied by vomiting; fever which ranged from 99° to 100°. The onset of these attacks was usually gradual, being attributed oftentimes to some dietary indiscretion, but not infrequently they passed off quite abruptly. Two weeks before he was seen he had an attack, and again three days before another attack which had practically subsided. The bowels had moved from cathartics.

On examination of the abdomen at this time, there was not much to be made out. Two slightly tender areas were present, one at McBurney's point and another at a point slightly above and a hand's breadth to the left of the umbilicus. No muscular rigidity and no masses were felt. The temperature was 99° and the pulse 80. The urine was normal.

## STAB WOUND OF THE DEEP EPIGASTRIC ARTERY

oblique are pushed upward and the transversalis fascia is incised, exposing the deep epigastric vessels in their first stage, and the ligature is applied as shown in the cut (Fig. 2).

The deep epigastric artery is involved in the following surgical conditions:

(1) Stab or gunshot wounds, already considered.

(2) Spontaneous hæmatoma of the rectus muscle, a case of which was presented before this Academy by Dr. John Speese.<sup>7</sup>

(3) Injury in paracentesis abdominis. This subject has been thoroughly worked up by Trzebicky.<sup>8</sup>

(4) Division during a cœliotomy incision. Here the conditions are the same as when the artery is divided by a stab wound, and they must be dealt with accordingly, remembering to ligate both ends.

(5) Postoperative secondary hemorrhage, especially in drainage cases. Here it is the custom to pack, but ligation of the vessel at its origin is both surer and safer, and prevents recurrence of secondary hemorrhage with possibly fatal results.

(6) Division of anomalous obturator artery when cutting Gimbernat's ligament to relieve the constriction of a strangulated femoral hernia. Since this accident cannot be foreseen when working from below, it may be avoided to some extent by dulling the blade of the herniotome, so that while it is sharp enough to divide the dense Gimbernat ligament, yet it is so dull that it pushes the artery before it. It should be borne in mind, also, that the merest nick of the constricting tissue is usually all that is necessary to enable the strangulation to be overcome. In case of uncontrollable hemorrhage from the vessel it must be ligated close to its origin from the deep epigastric artery in the manner already described for the latter vessel, and as shown in the sketch (Fig. 2).

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<sup>7</sup> ANNALS OF SURGERY, February, 1916, 245.

<sup>8</sup> Archiv f. klin. Chirurg., 1890-1891, xli, 850-65.

artery. In the region of the duodenum Moynihan and Dobson describe nine fossæ: (1) Superior duodenal; (2) inferior duodenal (fossa of Treitz); (3) paraduodenal (fossa of Landzert); (4) mesentericoparietal (fossa of Waldeyer); (5) mesocolic; (6) posterior duodenal; (7) duodenojejunal; (8) intermesocolic; (9) infraduodenal. Of these the last four are unimportant and oftentimes absent. The third and fourth are the ones most often implicated in the formation of hernia, giving rise respectively to left duodenal and right duodenal hernia. The former of these has the inferior mesenteric vein, often accompanied by the left colic artery, on the anterior margin of the neck of the sac; the latter has the superior mesenteric artery in a corresponding position.

The exact mechanism of production of this type of hernia is not altogether clear. It is difficult to explain why hernia in this region is so infrequent when one or more fossæ are constantly present. It is well known that in practically every case one finds a vessel of greater or less size and importance in the free border of the original fold. It would seem that the location and laxity of this vessel is the predisposing cause of hernia formation: if this vessel is small and closely applied to the underlying tissues with a resultant fossa that is shallow, the likelihood of hernia is remote; on the contrary, if this vessel is large and lax with a resultant broad fold and deep fossa, the constant boring, peristaltic action of the intestine may gradually deepen the preëxisting fossa until the sac of considerable size is produced. Into this sac a part or whole of the small intestine may pass; Freeman<sup>3</sup> has reported a case where the sac contained the cæcum and part of the colon as well.

*Incidence.*—These herniæ affect all ages and conditions of man; they occur in the young and the old. Brösieke<sup>4</sup> has recorded an example in a child fourteen days old; this case is a potent argument for the congenital origin of the condition.

Moynihan and Dobson were able to collect from the literature sixty-five cases of left and seventeen cases of right duodenal hernia. In addition there have been a few instances of the rarer types. Since the report of these cases, Short<sup>5</sup> has collected fourteen cases of the former variety and one of the latter. There are three cases reported in American literature which Short has omitted; these are by Davis,<sup>6</sup> Primrose,<sup>2</sup> and Nuzum and Nuzum.<sup>7</sup> The first and last of these are the more frequent left duodenal type. Primrose's case is unique in that it was due to an aberrant middle colic artery, an extremely rare

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No preoperative diagnosis was made. Appendicitis naturally suggested itself. An operation was done for exploratory purposes.

A long right rectus incision was made. The appendix was free from inflammation and adhesions; it was removed. The gall-bladder, stomach and duodenum were quite normal. On following the ileum from the cæcum one encountered a very unusual condition: it was what at first appeared to be an enormously dilated stomach. On closer inspection it proved to be a semitransparent sac through which could be seen numerous coils of small intestine. This sac extended into the left flank and downward to the pelvic brim, where it was loosely adherent. The transverse colon lay above the sac and the descending colon behind it. The sac with its contents was about the size of an adult's head.

With the hand far back in the flank, the entire mass was pulled out of its bed and brought into the incision. It was not until then that the exact nature of the condition was recognized; this was made possible by passing the hand from the right side downward and to the left, when the finger entered a rather tight ring from which two loops of small intestine were seen to emerge. One of these became continuous with the duodenum and the other with the cæcum; both were empty, as was also the colon. Slight stretching of the neck of the sac and gentle traction on the cæcal loop brought about reduction of the entire, moderately distended small intestine. The proximal four or five feet of jejunum was intensely congested and its lacteals were dilated; this condition soon returned to normal. Within a few seconds after reduction of the hernia, the transverse colon had become markedly distended with gas.

On the anterior surface of the neck of the sac there was a large vein, probably the inferior mesenteric. Just distal to this vessel the sac was quilted back and forth and tied loosely. It was thought best not to excise the sac.

The patient made a quick recovery and has remained quite well since the operation.

*Etiology.*—Our knowledge of retroperitoneal hernia is based principally on the exhaustive monograph of Moynihan and Dobson<sup>1</sup> published in 1906. This condition is usually due to the peritoneal folds and fossæ. There is a difference of opinion as to whether these folds are congenital or are due to traction; Moynihan leans to the latter view. Primrose<sup>2</sup> has recorded a case due to an aberrant middle colic

*Treatment.*—The treatment of this condition is the treatment of intestinal obstruction plus certain measures directed toward the hernia itself. The general condition of the patient will be the determining factor as to how much or how little should be done: enterostomy, on the one hand, may be the operation of necessity; or reduction and cure of the hernia, on the other, may be the procedure of choice.

With the abdomen open and the condition recognized, an attempt at reduction should be made by combined pressure on the sac and gentle traction on the afferent and efferent loops of intestine. Careful stretching of the neck of the sac may be an aid to reduction. Fortunately these simple measures will suffice in a great many cases. If they should fail, the sac should be opened well above the constriction and further attempts at reduction made. Finally, and this is particularly applicable in tightly strangulated cases, the intestines should be withdrawn through the opening in the sac, several small incisions made and the intestinal contents siphoned off; this procedure will permit of reduction of the traumatized intestine in difficult cases. Viability of the contained loops will determine what disposition should be made of the intestines.

Too much emphasis cannot be laid on the statement that the neck of the sac cannot be enlarged by actual incision, because of the close relationship of the inferior mesenteric vein in the one case and the superior mesenteric artery in the other. Division of either of these vessels would very probably eventuate in gangrene of a segment of intestine. There is on record one case, however, in which the operator divided the inferior mesenteric vein which he afterwards found to be thrombosed<sup>8</sup>; it is possible in this case that the occlusion of the vessel was sufficiently slow to allow the collateral circulation to develop.

After the hernia is reduced an attempt should be made to close the neck of the sac, due respect being paid to the neighboring blood-vessels. It is preferable to ligate the sac distal to the vessels rather than run the risk of tying or injuring one of these. Paton<sup>9</sup> has recorded a case where recurrence followed failure to close the sac.

*Prognosis.*—The prognosis of duodenal hernia is only relative, just as is the prognosis of intestinal obstruction. Early diagnosis and early operation will make possible a favorable outcome. These two factors are probably responsible for the improvement in recent statistics. Out of sixty-five cases of left duodenal hernia collected by Moynihan and Dobson up to 1906, only eight of those operated on

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anomaly; indeed, one doubts whether there is any justification for grouping it with duodenal hernia.

There are, then, eighty-one reported cases of left and eighteen of right duodenal hernia. No doubt cases have gone unrecognized and Short very aptly remarks that some fatal cases have probably passed unrecorded.

*Diagnosis.*—It will easily be seen that a correct diagnosis is most difficult. The symptoms for the most part are the symptoms of intestinal obstruction and naturally the various causes of obstruction must be differentiated. And after all, when a diagnosis of intestinal obstruction is once made, one is not justified in delaying in the hope of recognizing the underlying cause. Davis is of the opinion that "under favorable circumstances it is possible to make a probable diagnosis during life." He quotes Leichtenstern: "The circumscribed globular distention of the mesogastrium with retraction of the region corresponding to the colon; the firm, elastic, spherical lump which can be distinctly felt when the abdominal wall is thin, giving the impression of a large, somewhat movable cyst and extending from the mesogastrium to the left; the peculiarity that this well defined tumor always yields a sonorous note on percussion and clear intestinal sounds on auscultation, also the presence of hemorrhoids and the loss of blood from the rectum in consequence of the compression of the inferior mesenteric vein, permit, when taken in connection with the subjective troubles indicating chronic disease of the abdominal organs, a probable diagnosis to be made."

Moynihan states that "so far as the symptoms of the hernia are concerned there is little to be said. They may be slight or they may be the sudden symptoms of acute intestinal obstruction which swiftly strike the patient down. In a number of carefully recorded cases, the history of chronic slight digestive or intestinal troubles is usually obtained."

In direct contrast to those cases that have resulted in intestinal obstruction, mention should be made of a smaller group in which few or no symptoms are present; these cases are discovered at autopsy or during a routine examination of the abdomen at operation. The absence of symptoms, just as in any other type of hernia, is dependent on the absence of strangulation.

Ample proof of the difficulty of diagnosis is supplied by the fact that no recorded case—with one possible exception—has been diagnosed before operation.

## ISOLATED ABSCESS OF THE LIVER COMPLICATING APPENDICITIS

BY HENRY OTTO BRUGGEMAN, M.D.

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THE liver complications of appendicitis range from a banal icterus to acute yellow atrophy. It is probable that the functions of the liver are perturbed in every case of appendicitis. Credit must be given to the French clinicians for appreciating the importance and variety of these complications. Dieulafoy's term, *La foie appendiculaire*, expresses a conception of a relationship between inflammations of the appendix and the liver which has received but scant attention in America. The most important and best recognized hepatic complication of appendicitis is liver abscess. Reginald Fitz in his notable contribution to the subject of appendicitis discussed this complication. We now know that in the non-tropical countries appendicitis is the most common cause of hepatic abscess.

The classical description of appendicular hepatic abscess presents the picture of a condition with a fulminating symptomatology and a fatal termination. Most authors have accepted the teaching of Dieulafoy who, in his "Leçons Clinique," said that hepatic abscess secondary to appendicitis is always fatal. When Loison, in 1900, reported a case with recovery to the Paris Society of Surgery, Poirier and Tuffier questioned the diagnosis. Gerster speaks of the "utter hopelessness of the malady." Deaver states that he has never seen recovery occur. In 1912 Franke remarked that one can almost say that these pylephlebitic abscesses have an absolutely unfavorable prognosis "because they are always multiple." In May of the present year Lissner wrote: "Surgical interference, however thorough, will not save the patient when once the infection has reached the portal vein."

A patient of mine with appendicitis developed an hepatic abscess without exhibiting any grave symptoms and he completely recovered from his malady. The history is as follows:

A. M. D., a male, aged forty, and a carpenter-contractor by occupation, had a negative family history. He was ill four weeks in 1909 with what was diagnosed typhoid fever. He had a second attack of the same disease in 1913 that lasted nine weeks. He

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recovered. Whereas of the eighteen subsequent cases at least ten have recovered.

The prognosis in right duodenal hernia is far more grave than in left. Of the eighteen reported cases there has been only one recovery.

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revealed. An effort to examine the abscess cavity in the liver was checked because of the profuse hemorrhage that resulted. Large tubular drain was inserted into the abscess cavity. Patient made an uneventful recovery. Discharged from hospital May 25, with wounds all healed and liver palpable about two fingers-breadth below the costal arch.

Before the onset of jaundice and enlargement of the liver I believed that his complications were pulmonary. Later, owing to the mildness of his symptoms, his alcoholic history and my own ignorance of the type of liver abscess under consideration, I was inclined to make a diagnosis of an acute hepatic cirrhosis.

This case is not unique and its history is fairly typical of solitary abscess of the liver of appendicular origin. In 1911 E. Quénu and P. Mathieu reported a similar case and wrote that they had searched the literature and, including their own and two unpublished cases of Jalaguier, they had records of fourteen cases with operation, twelve of which recovered and two died of other complications. Three of the fourteen cases, however, probably had subphrenic and not hepatic abscesses. These authors did not exhaust the literature for they did not mention Parker Syms, Emanuel Herzel (Gerster), Munro, Sheen and Morton (Thompson), Hermes, Delangeniére (Abbadie), Elsberg, Perman (Carlson), Makrowski, Bidwell and Mgaloblishwili (Walter-Sallis), each of whom is to be credited with one operative recovery, nor J. Jason Clarke who reported two cases with recovery. Since 1911 Bittner, Brogden, Le Petit, Franke and Kelly have reported recoveries after operation.

In order to understand the pathogenesis of this affection one has but to recall that the appendix is richly supplied by veins and that blood from the appendiceal region pours directly into the liver. Practically it is impossible to separate this subject from that of pylephlebitis. Thrombophlebitis is an ordinary event in the course of inflammations of the appendix. There is nothing peculiar about the formation and character of these thrombi. In very rare instances a thrombus may form and extend through the portal vein, causing an abscess of the liver by direct continuity. Thompson, however, described a case in which there was no abscess of the liver although the branches of the portal vein in the liver substance were filled with pus. The commonest occurrence is for small septic emboli to become detached from a thrombus in the immediate neighborhood of the inflamed appendix and to travel through the superior mesenteric and portal veins to the liver. Usually such emboli are abundant and highly septic, so wide-

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was a heavy whiskey drinker, otherwise his previous personal history was uninteresting. On March 17, 1916, he developed severe colicky pains in the abdomen accompanied by vomiting. There was no recollection of localized pain. He continued working. March 23, he had another severe attack of abdominal pain and vomiting. On the night of March 24, he was awakened by excruciating, griping, abdominal pains that radiated to the penis. Vomiting occurred. Dr. C. M. Glock was called, and a diagnosis of appendicitis was made. Patient entered St. Joseph's Hospital on the morning of March 25. When I examined him at the hospital he presented the following symptoms: Temperature  $100.2^{\circ}$  F.; pulse-rate 86; rigidity of right lower abdominal quadrant; tenderness over appendix; moderate distention. He had a slight cough and some expectoration.

*Operation.*—Right rectus incision. Small amount of pus, well localized, was sponged out and a partly necrotic appendix removed. The appendix was adherent and directed downward and inward; its removal was fairly difficult. Split-rubber drain inserted.

March 28: Temperature normal. Drain removed. Considerable cough and expectoration. For the next two weeks the history was uneventful; the drainage which had a fecal odor steadily diminished in amount. Cough and expectoration continued.

April 13: Temperature  $101.4^{\circ}$ ; pulse-rate 90. Complained of vague distress in lower part of right chest. Dressing presented a small amount of brownish discharge. During the following three weeks the evening temperature varied from  $101^{\circ}$  to  $103^{\circ}$ , and the pulse-rate ranged from 80 to 96. Wound healed completely and patient insisted on moving about his room. At times he complained of dull pains and distress in hepatic region. Râles were detected over the base of the right lung.

April 21: He presented a slight general jaundice; the right lobe of the liver was palpable and tender two fingers-breadth below the costal arch.

April 22: A blood examination showed 12,300 white blood-cells with 74 per cent. of polymorphonuclears. Urine contained biliary pigments, otherwise normal. Fæces negative. Liver continued to enlarge until the right lobe was palpable a hand's breadth below the costal arch.

May 4: A tender fluctuating swelling was detected over the lower border of the liver.

May 5: Under ether anæsthesia an incision was made over the swelling and a large quantity of greenish-yellow pus welled forth. An opening into the liver that admitted the index finger was

dice, hepatic pain and tenderness and some increase in the size of the liver may be present. Quénu and Mathieu have emphasized the occurrence of a free interval when the temperature may return to normal, the appendix signs clear up, but the general condition remains unsatisfactory; finally the liver signs suddenly appear and the diagnosis is made. Unfortunately, many cases are not typical in their symptomatology and I cannot agree with the opinion of Quénu and Mathieu that the surgeon should be able to distinguish between these different types of hepatic suppuration. One can draw no positive conclusions from the time of onset or the latent period, the only certain method of differentiating is to open the abdomen and examine the liver.

Loison utilized the X-ray in making his diagnosis; various writers have conceded the diagnostic value of a Röntgen examination, but they do not seem to have employed it in their own cases. Exploratory puncture is generally condemned by American surgeons, although Koerte, Clarke, Kelly and others have resorted to this procedure in making the diagnosis.

When a solitary liver abscess complicates appendicitis, it is fair for us to assume that we are dealing with a mild infection. It is also reasonable for us to believe that any damage to the liver parenchyma would predispose to the occurrence of such an abscess. Jalaguier's patient with a gumma illustrates this point. Chloroform anæsthesia, which has a particularly injurious action on the liver substance, and alcohol must be regarded as predisposing factors. Walter-Sallis cannot accept the idea that the infection is facilitated by alcoholism, but Petréñ showed that four-fifths of the appendicitis patients who develop liver abscesses are males and he quotes LeGrand as proving that alcohol is a prime factor in the cause of amœbic abscess of the liver.

The case reports and the autopsy records, especially those studied by Loison, indicate that in the majority of instances the abscess is situated superficially on the convex surface of the liver.

Munro writes: "The age at which these infections take place is limited mostly to young adults. According to statistics of Musser and others, children below fifteen are quite exempt from portal infections." Petréñ's statistics clearly show that appendicitis patients between the ages of thirty and fifty are most liable to develop liver abscesses. It is a striking fact that proportionately a very large percentage of children have developed the isolated abscesses. Clarke's patients were both boys of less than nine years of age.

Early operations have made hepatic abscess a very infrequent sequel

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spread abscesses of the liver and death of the patient result. This is the classical hepatic complication of appendicitis. But, as in dysentery, a single embolus may be transported to the liver and a solitary abscess develop. Or, as Quénu and Mathieu have insisted, an aseptic embolus may reach the liver and produce a focus of necrosis which is capable of being infected in the course of a bacillæmia. In Jalaguier's case a syphilitic gumma played the rôle of a *locus minoris resistentiæ* and was infected during the course of an appendicitis. Loison showed that emboli can go from the region of the appendix to the liver without causing visible changes in the veins.

The abscesses of the liver usually occupy the right lobe. This is due chiefly to the distribution of the branches of the portal vein. Sérège (Quénu and Mathieu) seems to have proved by means of injections of Chinese ink that there are two currents of blood in the portal vein; one from the superior mesenteric, which goes to the right lobe, and one from the inferior mesenteric and splenic, which flows to the left lobe. It should be noted, however, that the left lobe alone may harbor the abscess.

We must admit that occasionally the infection travels to the liver along other avenues than the portal vein. It is possible that in rare instances infection takes place by way of the lymphatics. Munro has pointed out that the hepatic infections are not uncommonly associated with a lymphangitis, although the latter is not the source of the abscess in the liver. Koerte and others have believed that in certain cases the infection had journeyed to the liver along the retrocolic area. Out of eighteen cases studied in the Lund-Malonöer clinics (Petrén) it seemed that in one the infection had travelled along the retrocæcal way. Retrocolic infections are more likely to result in subphrenic abscesses. It must be a rare event for a subphrenic abscess to result in an hepatic abscess, but it is not so rare for subphrenic abscesses to result from hepatic abscesses. We have already considered the possibility of a bacillæmia causing an hepatic infection; however, when the infection takes place by way of the arteries it is usually but one of the manifestations of a general pyæmia.

In typical cases symptoms of these localized suppurations are quite unlike those of multiple liver abscesses. The onset of the latter is with chills followed by a rapid rise of temperature and grave general symptoms. The former starts less abruptly and usually does not display anything characteristic in its symptomatology. After a variable period an appendicitis patient presents some rise in temperature; jaun-

## HENRY OTTO BRUGGEMAN

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## ABSCESS OF LIVER COMPLICATING APPENDICITIS

of appendicitis. Babler states: "Murphy maintains that multiple abscess of the liver are a rare complication of appendicitis. Oschner, Deaver and several other prominent American surgeons have not seen more than one case." Recently Stillman discussed the post-operative sequelæ in 1748 cases of appendicitis; 124, or about 7 per cent., had sequelæ and of these 2 cases presented liver abscesses. The solitary forms constitute but a very small percentage of the total number of liver abscesses; however, their rarity does not excuse the surgeon if he fails to consider them when his appendicitis patients present an unexplained rise of temperature.

Eminent pathologists have taught that resorption of liver abscesses occurs. Munro held that the spontaneous healing of the liver abscesses which complicate appendicitis is not impossible. Hellström, in his admirable "Arbeit," proves that spontaneous resorption, even of the multiple abscesses, has occurred.

The treatment is purely operative. The conduct of the operation is the same as for hepatic suppurations of a different etiology; so far as recoveries are concerned the honors are equally divided between the transpleural and the abdominal routes. If one suspects an intra-hepatic collection of pus which cannot be localized the liver should be exposed by a large abdominal incision and carefully explored. Wilms is given credit by the European writers for advising the ligation and ablation of the mesenteric veins leading from the infected area, but Gerster first advised and practised this procedure; however, it is probably without value.

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majority of cases, anatomical conditions are normal in the abdomen, and the following steps of the operation can be accomplished without difficulty.

The operation proceeds now as in the usual hysterectomy, the round ligaments, broad ligaments and Fallopian tubes being severed, and the peritoneum sewed down to the attachment of the bladder and around the cervix. This stage of the procedure is clearly demonstrated in Fig. 2, which shows the tubes and ligaments tied off, and the sutured peritoneum in place.

Up to this point the operation has been familiar enough. The next step I believe to be original. The uterus is split longitudinally downward, to the point where the bladder is attached to the cervix, and the endometrium dissected out, from each cut section. Two incisions are now made through the aponeurosis and body of the rectus muscle, and through the peritoneum; each incision being distant one-half inch from the central incision through the rectus muscle, and each running in a direction parallel to it (the central incision). Each of these incisions should be large enough to permit one segment of the bisected fundus to be drawn through it. The position and purpose of these incisions are shown in Fig. 4 more clearly than can be described in writing. *A* is the central incision, *B* and *C* are the two side incisions, which positions are described above.

When these incisions have been made, a pair of vulsellum forceps is inserted through each, and the segments of the divided uterus are drawn through the apertures. The central incision through the rectus muscle and peritoneum is sutured, and the two parts of the uterus are brought together, being then sewn over the now united aponeurosis and muscle. The position and appearance of the uterus at this final stage may be likened to that of a finger ring. The uterus itself being the ring, its fundus taking the position that a stone in the ring would assume (that is, on the *dorsal* part of the finger), the cervix being that part of the ring upon the palmar surface of the finger. The rôle of the finger itself is played by the sutured central incision. It is now obviously impossible for the uterus to become displaced, and the skin and connective tissue are closed in after the usual fashion, over the fixed fundus of the uterus. The operation is now completed.

I have performed many other operations for this unfortunate condition, but the results have always been unsatisfactory and disappointing, whereas with this method, I have been universally successful.

# A NEW OPERATION FOR PROCIDENTIA UTERI

BY WILLIAM TOD HELMUTH, M.D.

OF NEW YORK

SURGEON TO FLOWER HOSPITAL

MANY different operations have been described for the surgical correction of this frequently encountered condition, a fact which implies the generally unsatisfactory nature of the results obtained. I myself have employed several of the described methods which I deemed to be the best, but have met with indifferent success, the operations being followed by a return of the prolapse, with its accompanying cystocele and rectocele, and in some cases there is a tendency of the entire trouble to return. At first I assumed that my technic was at fault, but, upon further investigation, found that men who have performed numerous operations of a like nature have encountered similar difficulties. Surgeons of wide experience complain that no entirely successful procedure is afforded at present.

I have recently devised an operation for procidentia uteri which has met with a greater measure of success than any other which I have previously employed. I believe this method which I now describe is in some degree original, and offer it for what it has been worth to me. If it dispenses with some of the difficulties experienced in the use of other methods (as it most certainly *has* done in my own practice), I believe it to be worthy of note.

The first step in the procedure is quite orthodox, and is accomplished as described in the text-books. I refer to the amputation of the cervix, concerning which I need only to advise that care be taken to avoid cutting the bladder. As is well known, in exaggerated cases of procidentia uteri, the uterus drags the bladder and the rectum down with it, and this condition is corrected, as will be explained in a later stage of the operation, by drawing up, and fastening in the abdomen, the body of the uterus.

After the amputation of the cervix has been accomplished, and the repair work on the perineum completed, the abdomen is opened in the median line as usual, the incision penetrating through skin, connective tissue, aponeurosis of the rectus muscle, and peritoneum. This incision should be free and large, and the intestines walled off with packing gauze, so that the operator may not be hampered in the inspection and manipulation of the parts to be attacked. In the



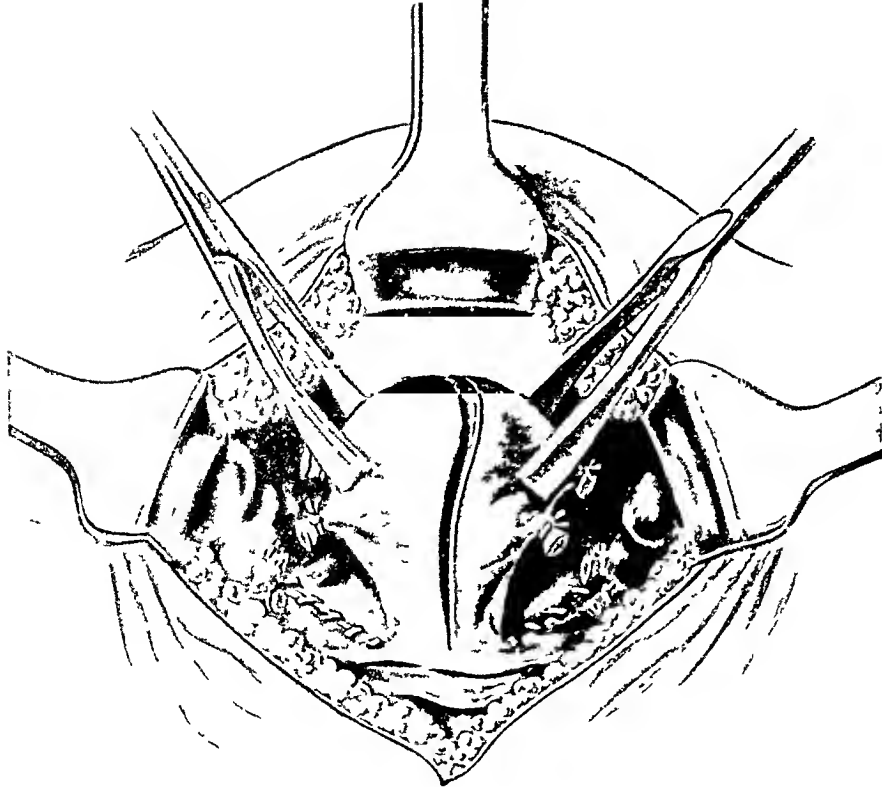


FIG. 3.—Uterus split longitudinally downward to the bladder attachment.

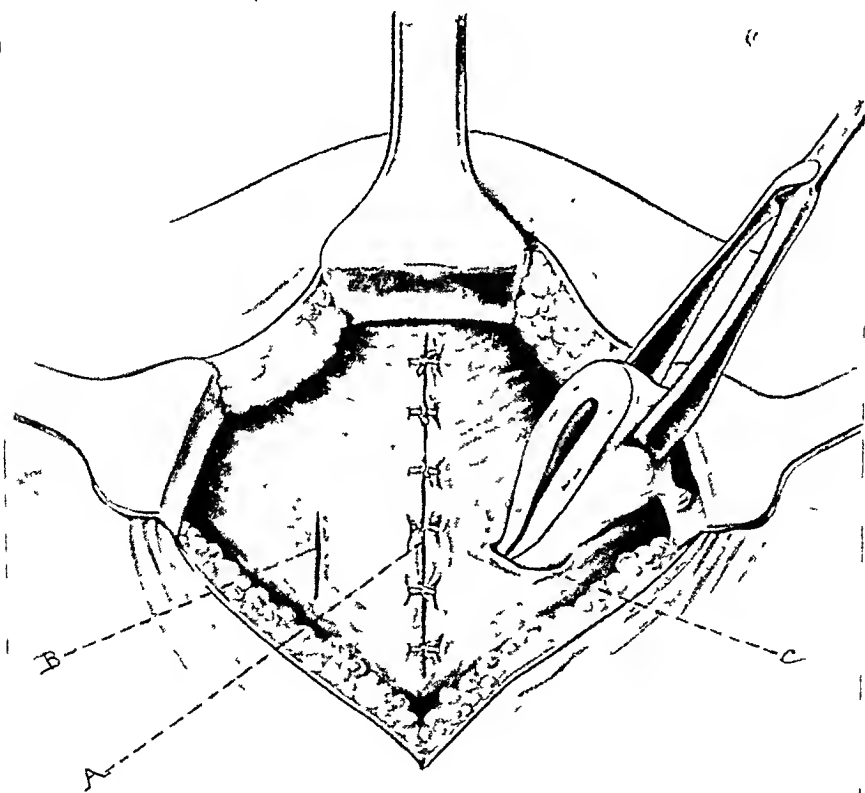


FIG. 4.—A, central incision; B, side incision through the aponeurosis muscle and peritoneum; C, side incision with one segment of the uterus drawn through.

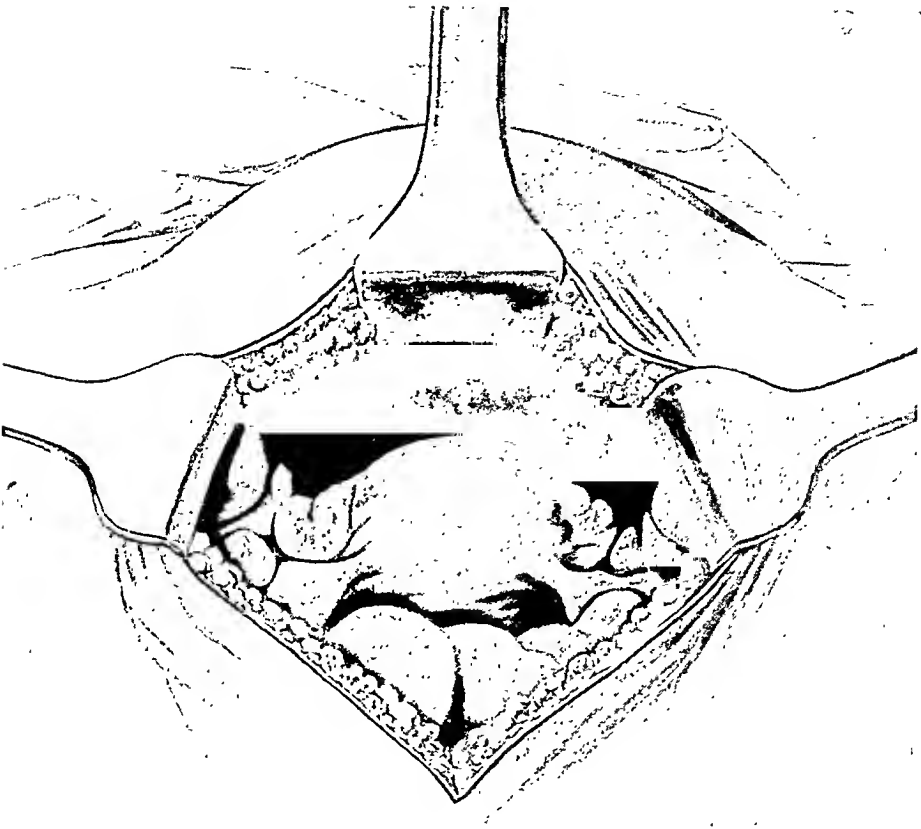


FIG. 1.—Exposure of parts to be attacked, through the first median incision.

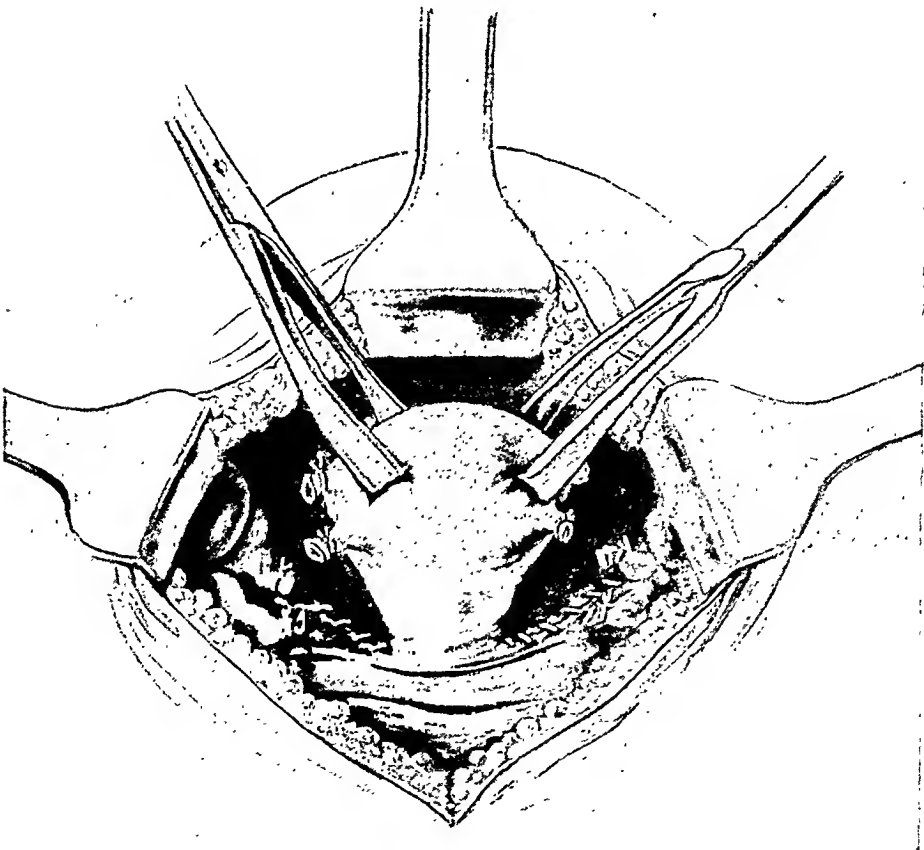


FIG. 2.—Showing tubes and ligaments tied off and the sutured peritoneum in place.

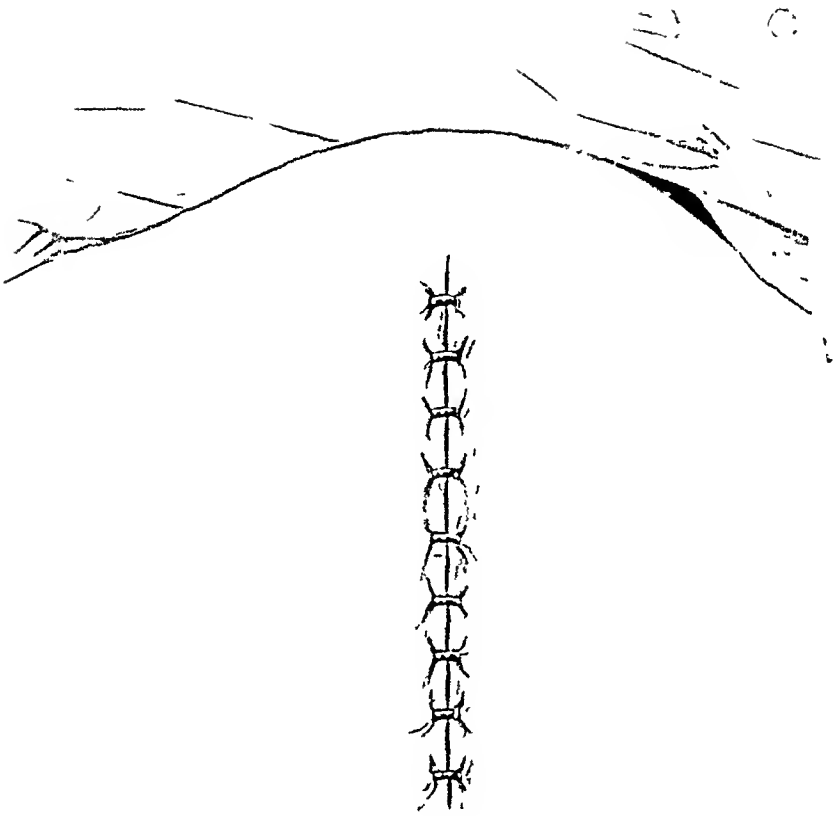


FIG. 7.—Skin and connective tissue closed over the fundus of the uterus by metal clips.

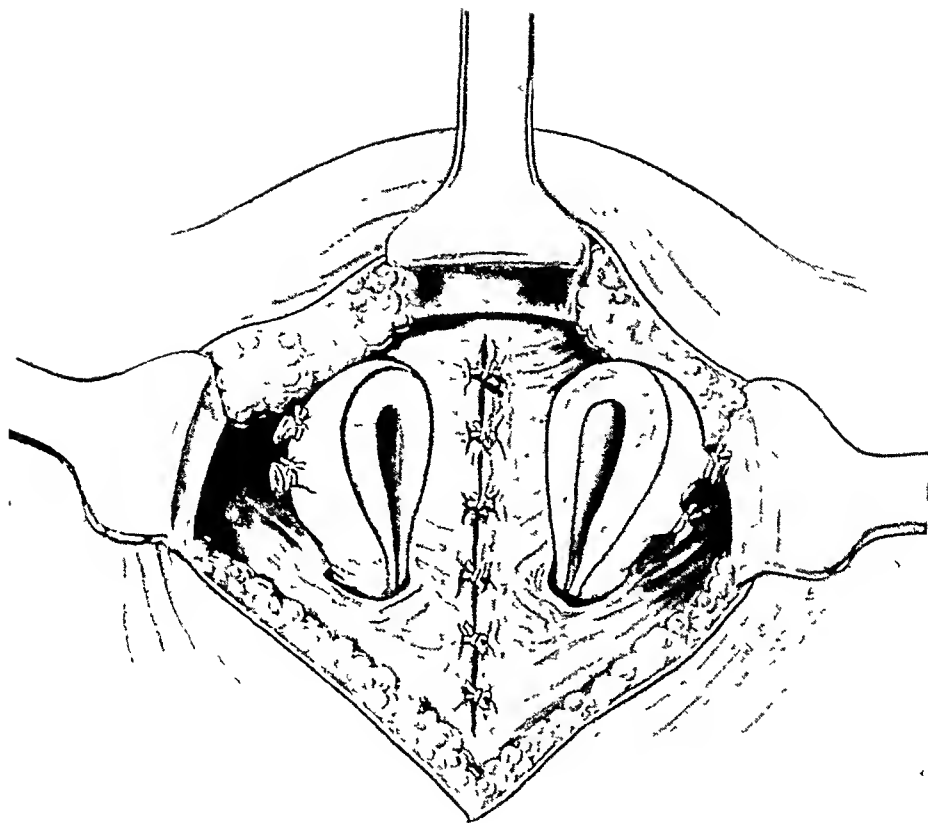


FIG. 5.—Both segments of uterus drawn through lateral incisions, and ready to be sutured together.

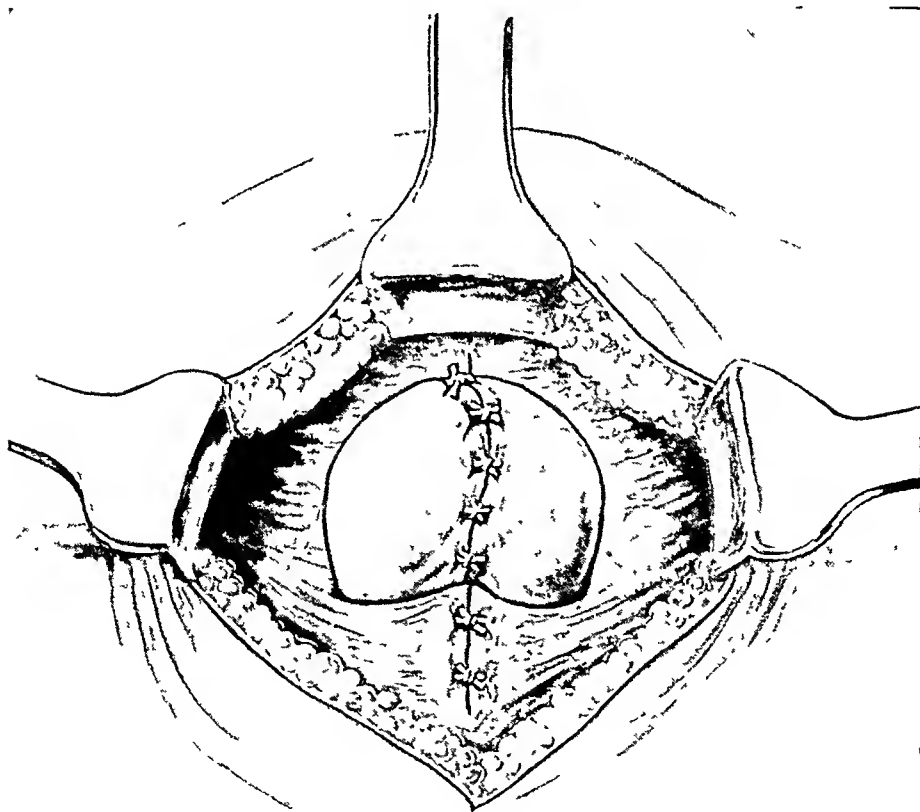


FIG. 6.—Uterus sewed over the united aponeurosis and muscle.

During post-mortem examination of patients, who have died of various diseases in the wards of our large city hospital, there can be frequently observed, in male subjects over forty years, indications of a mild degree of chronic prostatic disease with associated damage to the urinary tract above. It is generally found that no complaint has been made of this by the patient, it is usually unsuspected, unrecorded on the history, and has virtually never received treatment. In these cases, however, one finds at autopsy beginning trabeculation of the bladder, the presence of a slight bas-fond indicative of retention and back pressure, the ureters and renal pelves are dilated to a mild extent, and there is present a recent interstitial nephritis throughout both kidneys, and the renal parenchyma shows indications of pressure atrophy through its substance. When this pathology is viewed by one with a surgically trained mind, it is impossible to avoid the conclusion that the renal destruction, as the result of the partial retention of urine from the prostatic condition, has contributed to a certain extent to the lowering of the patient's power of resistance to a general infection, or has poisoned the heart muscle by the retained products of metabolism which should normally be excreted by the healthy kidneys. These patients succumb to other lethal affections, and their clinical and anatomico-pathological diagnoses rarely take into account the part played by the urinary obstruction, in fact it is the exception if any attention, either at the bedside or the post-mortem table, is directed toward such a diagnosis unless very marked changes are present. Clinically we know that frequently a patient bordering on uræmia and its fatal outcome is born anew to years of useful livelihood by the removal of the obstruction caused by an hypertrophied prostate, and the time is now ripe that *other* forms of vesical obstruction of equal danger should be similarly appreciated and appropriately treated, before the patient, handicapped and poisoned by his own faulty bladder function, succumbs to the first trial his bodily resistance is tested against.<sup>1</sup>

There have now been examined a total of 200 autopsy specimens in this series with ages varying from nineteen to seventy-nine years. Studying them by decades we find that:

From 10 to 20 years	there were	3 cases.
From 21 to 30 years	there were	21 cases.
From 31 to 40 years	there were	37 cases.
From 41 to 50 years	there were	51 cases.
From 51 to 60 years	there were	42 cases.
From 61 to 70 years	there were	33 cases.
From 71 to 80 years	there were	9 cases.
From 81 to 90 years	there were	0 cases.
And of age unknown	there were	4 cases.

# THE GROSS PATHOLOGY OF MEDIAN BAR FORMATION

BY ALEXANDER RANDALL, M.D.  
OF PHILADELPHIA

IN 1830 G. J. Guthrie, of England, first described median bar formation as a cause of vesical obstruction. His contribution was read before the Royal College of London under title of "Bar at the Neck of the Bladder." During the sixty years that followed the subject received but scant attention from surgeons, with the possible exception of the work of Mercier. For the past two decades this form of obstruction to urination has been studied anew from many points of view, so that we now have a very complete understanding of the character of such obstructive formation. This knowledge includes the clinical symptomatology and diagnosis, the cystoscopic appearance and examination, and the various operative procedures devised for its relief. Again, the tissue removed in the cases of true bar formation by operative means has been subjected to microscopic section as to its minute pathology, so that one might to-day say that the only chapter of median bar formation left unexplored is the gross pathological picture of the condition.

It does seem strange that isolated gross specimens of median bar formation have not been recognized and recorded previously by investigators, either surgeons or pathologists, and I am afraid that it is due to the neglect to investigate these parts routinely at the post-mortem table. There are to my knowledge to-day, after a comprehensive review of the literature, but three illustrations of what we designate as median bar formation; the first by Mercier in 1850, the second by Englisch in 1901—both rough wood cuts—and the third by Watson.

Appreciating that the ideal way would be to trace clinical cases through their post-mortem examination in order to obtain such gross specimens of median bar formation, it was found that the rarity of such opportunities, and the lack of the appreciation of its clinical symptomatology, forbade such a course, and it seemed the wiser procedure to cast aside the detail of the many failures that were bound to occur, and to examine a long series of bladders, urethras, and prostates, as they came to the autopsy table, irrespective of age or clinical diagnosis, hoping thereby to obtain a few specimens in the series which presented the gross changes of median bar formation, trusting to *other* than clinical means to determine the diagnosis, and to have illustrations made of the findings so obtained.

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\* Read before the Philadelphia Academy of Surgery, January 8, 1917.

ically composed of fibrous tissue and is definitely sclerotic from connective tissue proliferation. It is always associated with small, non-hypertrophied lateral prostatic lobes, and has been present in three of the eight cases classified as "large" bar formation.

2. In the second type the bar has an upward tendency of growth, and seems to encroach upon, or draw upon, the vesical trigone more than upon the urethral surface. This type is characterized by an infolding, or creasing, of the vesical trigone transversely, and is the type more readily appreciated cystoscopically by reason of the above characteristic and by the proximity of the ureteral orifices to the vesical outlet. This type has been least frequently found in this series of cases and likewise shows less tendency to obstructive changes. There were found in all three specimens of this type of bar in the entire series. On cross-section it is composed of fibrous tissue similar to that found in Type 1, and has simply expended its efforts in a different direction and is not associated with the urethral shortening so characteristic of the former.

3. In the third type there is formed a bar due to glandular hypertrophy which has its origin in the true median lobe glands, under the sphincter muscle and within the prostatic capsule. This is often the most prominent feature of a beginning general hypertrophy and the early cause of obstruction to the emptying of the bladder. Slight hypertrophy at this point will cause the formation of a thick, broad, rounded-edged bar of quite different character from that of the other two types, and will cause an obstruction at the orifice, long before a correlative amount of hypertrophy in the lateral lobes assumes any importance whatever. On section there will be found a definite layer of uninvolved tissue three to four millimetres in thickness composed of the mucous and submucous layers, under which will be found definitely hypertrophic glandular tissue occupying the situation of the median lobe acini in the posterior prostatic commissure, with a well-marked encapsulation. This type of obstructive bar is without question the most frequent variety, and seems to be the prevalent location where hypertrophic changes are most apt to start.

4. The fourth type of bar formation is that due to an hypertrophy of the subcervical glands of Albarran<sup>1</sup> alone. These hypertrophies have proven to be quite frequent and rarely develop as a definite bar, but rapidly assume the shape of a perfectly rounded lobe with deep lateral cleftings, and, though often causing marked evidences of

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<sup>1</sup> The simultaneous association of hypertrophic changes in both the posterior commissure and the subcervical glands of Albarran are now under investigation by microscopic study.

It is interesting to note that in this series of 200 cases 46 (23 per cent.) have shown gross pathological changes of one kind or another in either the bladder, the prostate, the posterior urethra, or the seminal vesicles, and the returns from this mode of study have been most lucrative and interesting in all branches of urological pathology.

There have been found 28 specimens of median bar formation, 14 per cent. of the total number of specimens examined showing changes of this type.

Of these 28 median bar cases 8 specimens are recorded as large, by which I mean that there is no doubt that the condition as found must have caused some urinary obstruction and retention, and that the size of the bar and the visible damage to the urinary tract above stood out as a marked abnormality on examination of the specimen. They represent 4 per cent. of the total series and occurred at the ages of forty-six, fifty, fifty-four, fifty-eight, sixty, sixty-seven, and seventy-nine years.

In the remaining 20 cases (10 per cent.), the bar is recorded as small, meaning thereby that though the abnormality was unmistakable on macroscopic examination, the condition was not of so pronounced a degree, nor was it associated with other changes that would make me feel positive that urinary obstruction, of importance or degree sufficient to cause retention, had yet occurred. They are simply the early cases, where development had not reached such a degree as in the previous group. In these the ages are recorded as from twenty-six to seventy-four years. The average age for the cases classified as large bars is 57.7 years and for the small bars 47.5 years, a difference in figures that was to be expected, but not to be considered weighty, except from a clinical and diagnostic standpoint, for with but few omissions they are all within the age when hypertrophy of the prostate may be expected to be the cause of the condition.

In studying these specimens grossly it has been possible to group them into four types which may be described as follows:

1. A type of abrupt bar or dam, rising from, or better stretched across, the posterior lip of the vesical orifice, formed of firm, dense, sclerotic tissue, whose edge is sharp and narrow, and whose lateral terminations form an abrupt angle with the lateral walls of the vesical outlet. In these cases one is apt to find that the so-called urethral trigone—that fan-shaped, striated area, which normally spreads downward from the posterior vesical orifice to converge upon the formation of the verumontanum—has been distinctly shortened, and in marked cases the verumontanum is drawn up directly under the abrupt rise that forms the median bar. This type of bar on cross section is macroscop-



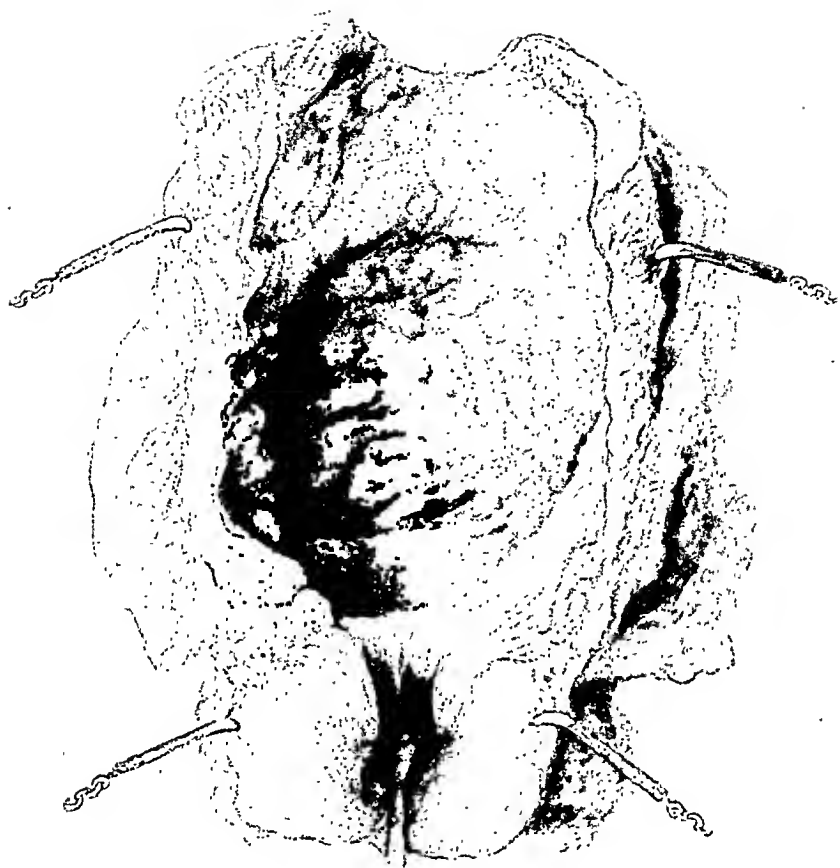


FIG. 2.—Median bar; fibrous; Type 1. Specimen No. 3850. F. H., aged sixty-seven years. Entered the Men's Medical Ward on December 21, 1915. Profoundly toxic, catheterization necessary, urinary output small. Died December 27, 1915. Clinical diagnosis: Lobar pneumonia, chronic myocarditis, chronic nephritis. Anatomical diagnosis: Lobar pneumonia, pleurisy, chronic interstitial nephritis, hypertrophy and dilatation of heart. Specimen shows good bar formation; urethral trigone very much shortened with verumontanum drawn up close under the breast of the median bar. Vesical trigone and prostate normal in outline and size. Note the abrupt angle to the normal course of the urethra where the bar occurs. There was likewise a diverticulum in the vertex of the bladder not shown in this illustration.

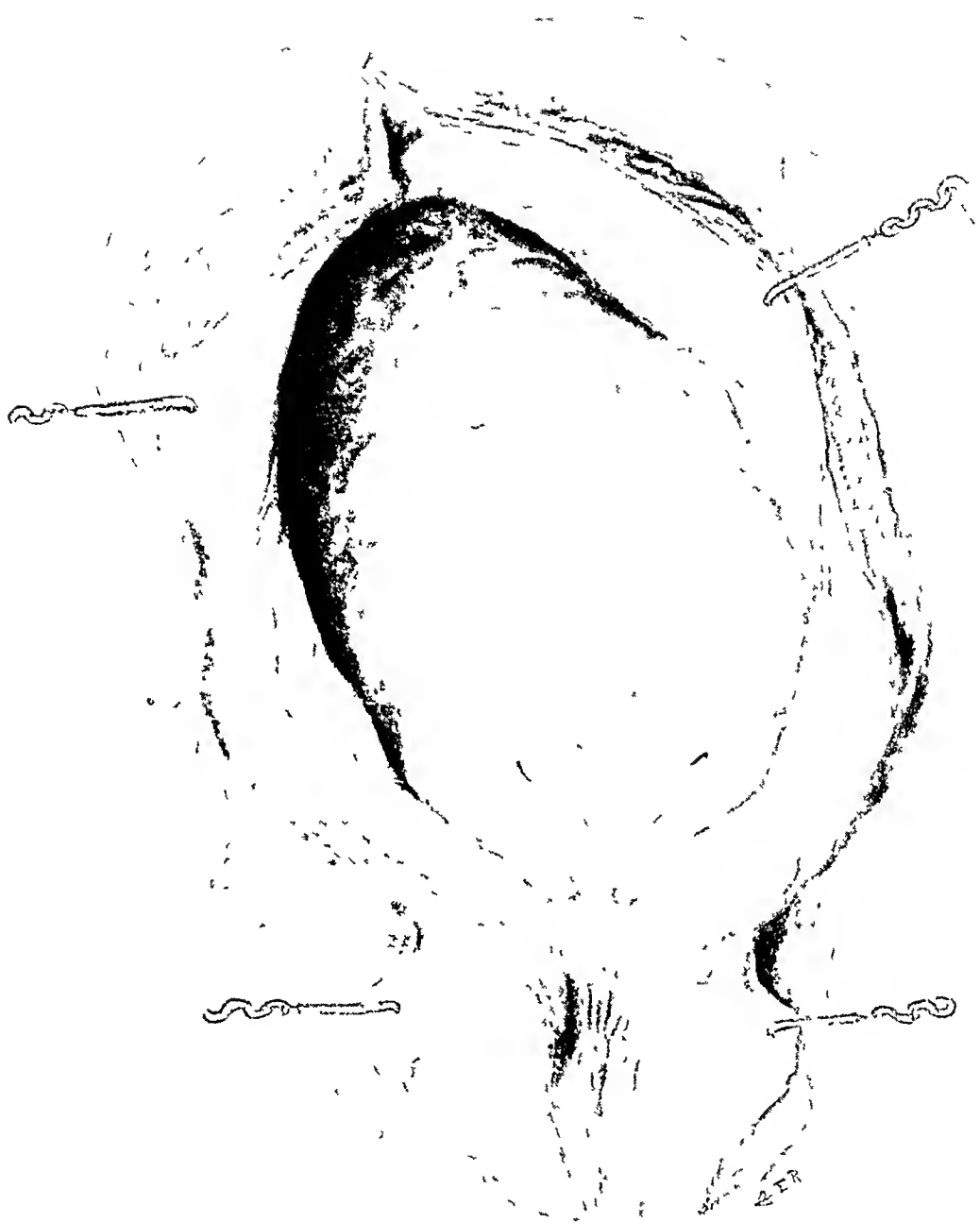


FIG. 1—Specimen No. 3927 Shows the normal bladder cavity, trigone, vesical orifice, urethra, and prostate of a male, dying at the age of forty-two years, as viewed when opened along the ventral or anterior surface. Note size and relative positions of ureteral orifices, trigone, uvula vesicæ, urethral trigone, verumontanum, and size of prostate. The proportions are drawn to the scale of life size, to which all the following illustrations may be compared, as the same scale has been maintained throughout.

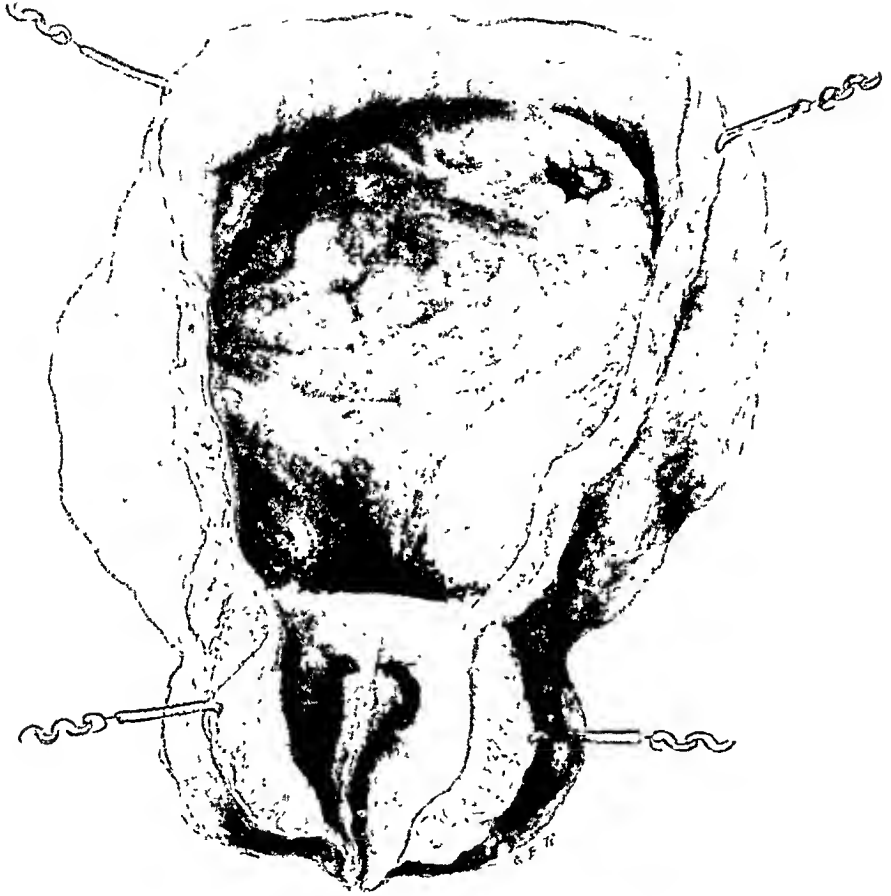


FIG. 4.—Median bar; fibrous; Type 1. Specimen No. 3871. M. G., aged sixty. Entered Medical Ward, January 14, 1916. Suffering with an acute attack of influenza. Died January 20, 1916. Clinical diagnosis: Lobular pneumonia. Anatomical diagnosis: Lobular pneumonia, pleurisy, parenchymatous nephritis, early interstitial nephritis. Specimen shows a thick, short bar, with marked shortening of the urethral trigone, verumontanum being drawn up directly under the base of the median bar formation. Prostate of normal size, vesical trigone of the Y-shaped variety. Evidence of urinary obstruction seen in the formation of the small diverticulum in the vertex of the bladder.



FIG. 3.—Median bar; fibrous, Type 1. Specimen No. 3850. Same as Fig. 2, drawn after sagittal section of the specimen, giving in clear detail the position of the bar, character of tissue, location of verumontanum, and abrupt angle to the normal urethral course.



FIG. 6.—Median bar; fibrous, Type 2. Specimen No 3959. A. F., aged fifty-five. Entered Tuberculous Ward December 21, 1915. History gives no note on any genito-urinary complaint. Died March 30, 1916. Clinical diagnosis: Pulmonary tuberculosis. Anatomical diagnosis: Ulcerative and conglomerative pulmonary tuberculosis, chronic parenchymatous nephritis, slight dilatation of right ureter. Specimen shows the second variety of bar where the encroachment is upward and upon the vesical trigone. The urethral surface is but little if any shortened, but the bar is definitely present and there is a deep transverse clefting or creasing of the vesical trigone that brings the ureteral orifices in close approximation to the vesical orifice. The bladder wall is as yet undamaged except for the presence of a decided bas-fond.



FIG. 5.—Median bar; fibrous; Type 2. Specimen No. 3834. C. T., aged seventy-six. Entered the hospital July 17, 1914. History highly suggestive of carcinoma of the œsophagus, and after a protracted confinement the patient died December 10, 1915. Clinical diagnosis: Carcinoma of the œsophagus, chronic myocarditis, arteriosclerosis. Anatomical diagnosis: Carcinoma of the œsophagus, stomach, and liver; chronic diffuse nephritis. Specimen a good illustration of bar formation and of the second type which is characterized by encroachment on the vesical trigone, with shortening and transverse creasing of it, rather than on the urethral surface. There is a well-marked bas-fond and beginning trabeculation and thinning in the bladder walls. No prostatic enlargement.



FIG. 8—Median bar, glandular; Type 3. Specimen No. 4071. W. I. L., aged twenty-six. Entered the Medical Ward July 14, 1916, with acute pulmonary symptoms. He gave a history of having had a Neisserian infection fifteen years ago. There are no genito-urinary symptoms recorded on the history. He died a typical pulmonary death July 16, 1916. Clinical diagnosis: Lobar pneumonia. Anatomical diagnosis: Lobar pneumonia, cloudy swelling of kidneys. The specimen shows a small bladder with thick (hypertrophied) walls. There is a definite bar at the vesical orifice of the thick glandular type. The hypertrophy of the bladder musculature has been in an effort to overcome the beginning obstruction, and helped by youth the compensation has apparently been complete to the time of death. Section of the bar in the midline demonstrated an increase in the prostatic glandular tissue of the posterior commissure, early hypertrophy at this point having been responsible for the bar formation.

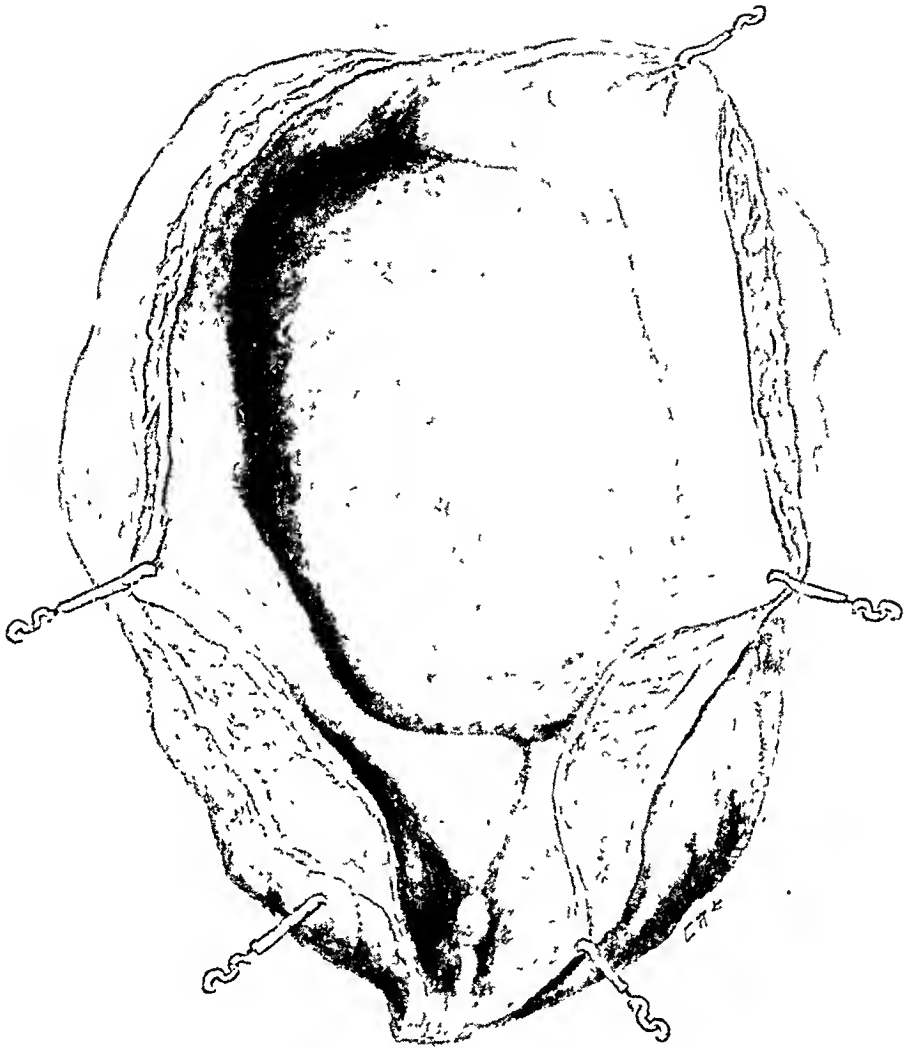


FIG. 7.—Median bar; glandular; Type 3. Specimen No. 4123. G. F. H., aged fifty-six. Entered the Men's Medical Ward May 17, 1916, complaining of shortness of breath and general cardiac symptoms of eighteen months' duration. History of a specific urethritis in youth. Physical examination reveals general symptoms of broken compensation and Cheyne-Stokes respiration. History notes urinary output as small, urine examination shows low specific gravity, trace of albumin, and a few hyaline casts. Patient died October 1, 1916. Clinical diagnosis: Myocarditis, decompensation, chronic interstitial nephritis. Anatomical diagnosis: General anasarca, dilatation of heart, chronic fibroid myocarditis, multiple pulmonary infarcts, chronic diffuse nephritis. The specimen is one of glandular bar formation due to hypertrophic glandular changes in the posterior prostatic commissure. The bar is thick, rounded, and firm. The bar has an upward tendency of growth causing, as is characteristic of Type 2, a transverse creasing of the vesical trigone; however, grossly, it in no wise resembles a fibrous type of bar. The lateral prostatic lobes are slightly enlarged. The bladder wall decidedly hypertrophied.



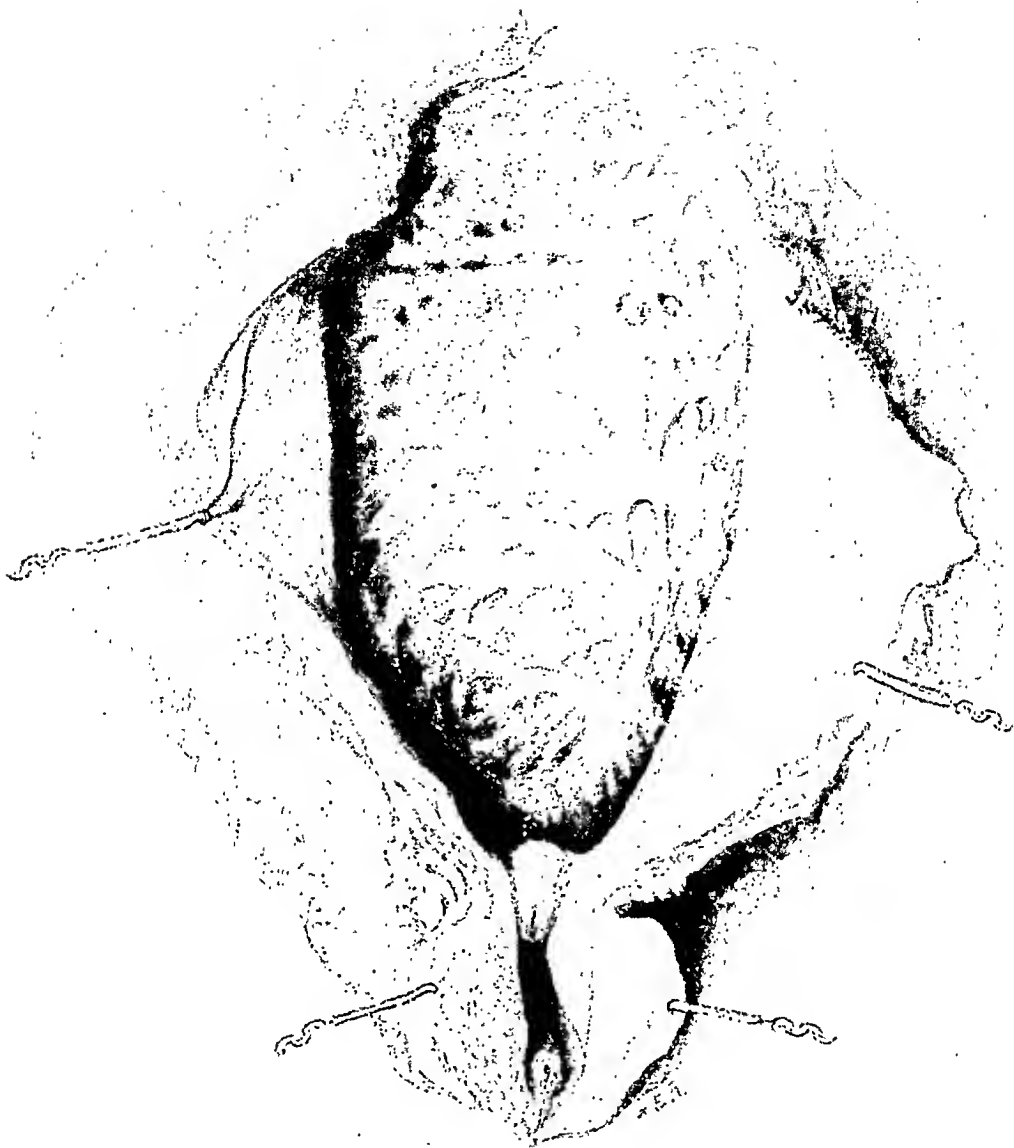


FIG. 10.—Median bar; glandular; Type 4. Specimen No. 3963. G. S., aged fifty. Entered the Insane Wards, February 2, 1916. He had been picked up on the street by the police, gave evidences of having lived a tramp's life, could give no coherent statement as to his past and lacked any knowledge of the present. His history notes general lessening of mental faculties, restlessness, senility, and dementia. He is incontinent. Wassermann is negative. Died March 30, 1916. Clinical diagnosis: Senile dementia, arteriosclerosis, dry gangrene of right foot. Anatomical diagnosis: Bronchopneumonia, chronic interstitial nephritis, obliterative arteritis of right posterior tibial artery. Specimen shows a small nodular hypertrophy at the vesical orifice. Behind this is a highly trabeculated bladder wall giving all the necessary evidence of having worked against a gradually increasing degree of obstruction. This nodular hypertrophy is situated just under the mucous membrane, is not associated with any hypertrophy of the prostatic lobes, nor was there any stricture of the urethra present. This type of obstruction is due to an isolated hypertrophy of the subcervical group of glands of Albarran.

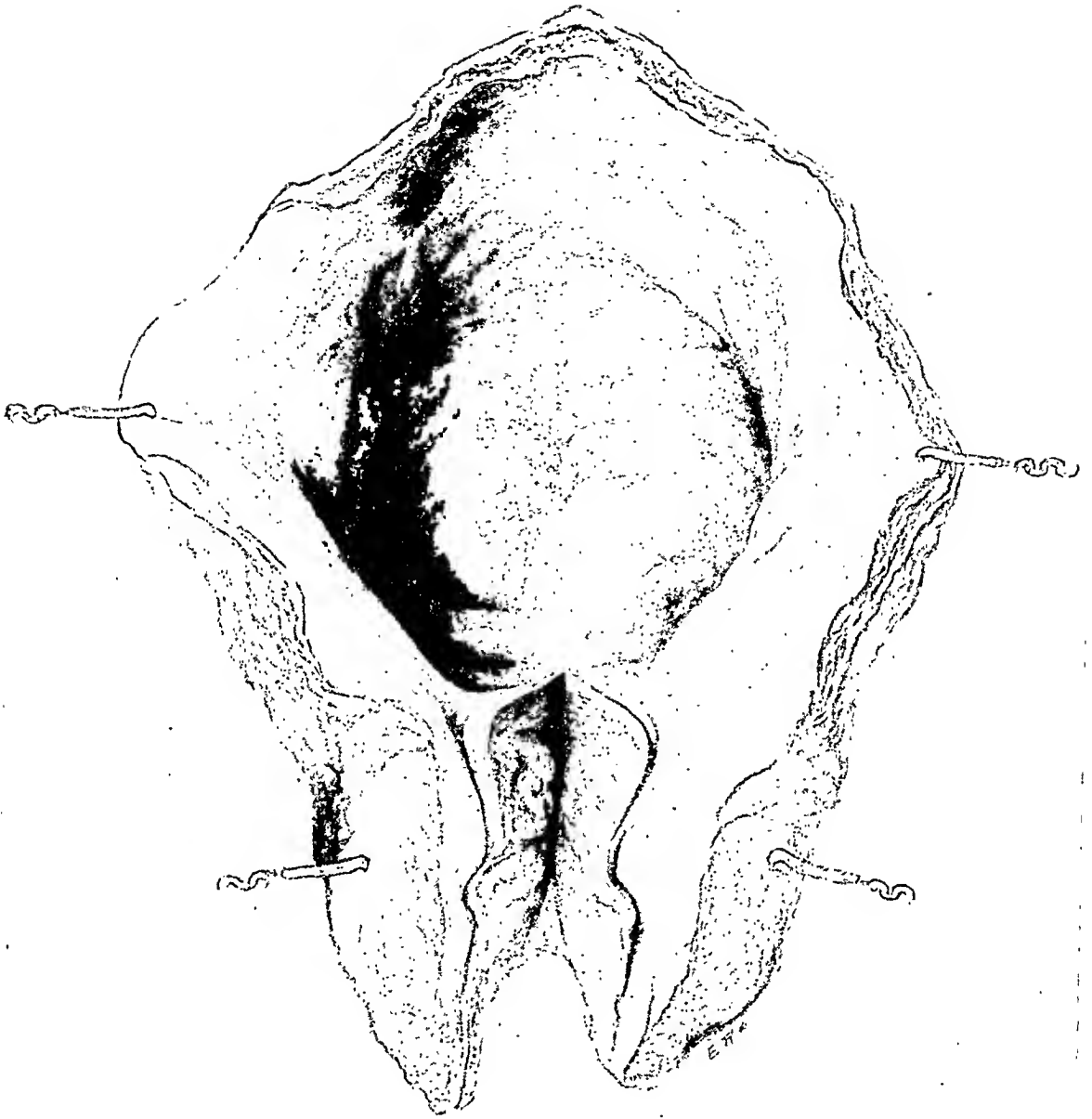


FIG. 9.—Median bar; glandular; Type 3. Specimen No. 4039. F. K. B., aged fifty. Entered the Neurological Ward, May 30, 1916, complaining of pains in his legs and head, and an unsteady gait. Only genito-urinary note in the history is the occurrence of a specific urethritis six years previously. Patient died in an apoplectic stroke on June 9, 1916. Clinical diagnosis: Cerebral hemorrhage. Anatomical diagnosis: Intracranial tumor, bronchopneumonia, cloudy swelling of kidneys. Specimen is one of the thick median bars which has been incised in the midline to again demonstrate the hypertrophic glandular tissue in the posterior prostatic commissure as the cause of the bar formation. There is a very slight amount of lateral hypertrophy, and the bladder wall is beginning to give way and to dilate its walls being considerably thinned



FIG 12 —Median bar, glandular; Type 4. Specimen No. 3967. A. B., aged sixty-seven. Entered the Medical Ward, March 20, 1916, complaining of abdominal pain, dizziness, and paralysis of right leg. Patient found to be very weak, pain in abdomen of five days' duration and of shooting character. Inability to use right leg of four days' duration and gradually increasing in its extent. No venereal history. Patient very emaciated, semicomatose, incontinence of urine and feces. Heart sounds weak, chest negative, abdomen rigid, but with no localizing tenderness. He became progressively weaker and right-sided hemiplegia developed, and he died March 31, 1916. Clinical diagnosis: Cerebral thrombosis. Anatomical diagnosis: Bronchopneumonia, chronic fibrous pleurisy, chronic interstitial myocarditis, chronic valvulitis, arteriosclerosis, chronic interstitial nephritis. Specimen shows a lobular median obstruction with deep lateral cleftings. It is superficial and covered only by the mucous membrane. Bas-fond well developed, bladder walls hypertrophied, prostate normal in size. Like the two preceding specimens it represents an isolated hypertrophy of the subcervical glands of Albarran.



FIG. 11.—Median bar; glandular; Type 4. Specimen No. 3824. H. A. R., aged fifty-four. Entered the Genito-urinary Ward, November 27, 1915, in a semiconscious condition. Incontinence of urine. A very large hydrocele was aspirated on December 1, 1915, and the patient transferred to the Neurological Department with the diagnosis of gumma of the brain. Wassermann positive. Died December 3, 1915. Clinical diagnosis: Cerebrospinal lues, chronic interstitial nephritis. Anatomical diagnosis: Multiple gummata of the brain, oedema of the lungs, chronic diffuse nephritis. Specimen shows in the gross a slight median bar formation which mesial section demonstrates to be due to a small cluster of gland acini, visible to the naked eye, situated immediately in the edge of the bar. The bar in this case was so small that not until sectioned and the above noted, was it considered worthy of preservation. It is undoubtedly a very early hypertrophy of the subcervical glands of Albarran, further enlargement of which produces the isolated median lobe hypertrophics.

## HÆMANGIOMA CAVERNOSUM OF BONE\*

BY JAMES M. HITZROT, M.D.

OF NEW YORK CITY

HÆMANGIOMA cavernosum or cavernoma as a bone tumor is sufficiently rare to warrant the publication of the following case, which, in so far as can be discovered from the literature, is the only case of this type located in the upper end of the humerus so far reported, and the only X-ray picture of this lesion in existence in so far as I know.

C. R. M., physician, aged twenty-five, consulted me in January, 1916, for pain he was having in the right shoulder with some swelling about the shoulder-joint. He dates his present illness to an injury received six years ago while playing basket ball. The injury was accompanied by pain in the shoulder, dull aching in character, with tenderness over the head of the humerus and inability to use the shoulder-joint. This pain, etc., persisted for four months and finally disappeared with treatment by baking and by salicylates internally.

Four years later, two years ago, the pain reappeared in the shoulder after some unusual exertion and at this time the pain was chiefly evident upon attempts to use the arm. Following this attack there was crepitus in the joint. This second attack was also relieved by baking and salicylates. X-ray plates taken at this time were said to show nothing abnormal.

Off and on since then the patient has suffered from slight pain in the shoulder-joint following active use of that joint, and this pain was always relieved by salicylates. Four weeks before consulting me he began to suffer from severe pain in the right shoulder accompanied by inability to abduct the arm, except with care and then only partially. With these attempted movements, shooting pains caused the patient to stop. There was distinct tenderness over the head of the humerus, and at this time he thought there was a perceptible enlargement in the region of the right deltoid.

His past history showed measles, scarlet fever, whooping cough, diphtheria. Three and a half years ago he had typhoid fever with extensive phlebitis including both axillary veins. At

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\* Presented to the New York Surgical Society, March 8, 1916.

urinary obstruction, even when quite small, are seldom in the class of true bar formation. Several beautiful specimens of such isolated hypertrophies have been encountered in this series, and it has been a matter of difficulty to decide whether to group them with the bar cases where clinically they belong, or under prostatic hypertrophy which anatomically they are.

Clinically both these types of glandular hypertrophies cause urinary obstruction, and the size will often obliterate the anatomical origin. Moderate-sized enlargements form a borderline group where personal opinion alone can be used in deciding the anatomical origin as between the glandular bar and the solitary hypertrophied subcervical glands.

If one bears in mind the close similarity of the symptomatology of all vesical neck obstructions and the four types here differentiated, one can then readily appreciate that first of all (*a*) the surgical treatment must of necessity be different as between the median bar formation and generalized prostatic hypertrophy; (*b*) that, second, the mode of treating the various types of bars will differ according to the variety present; (*c*) and, third, that the differential diagnosis in the living must depend entirely upon an accurate cystoscopic study of the vesical orifice.

a small opening in the bone filled with altered blood clot. The tumor was then chiseled away from the shaft of the humerus and from the greater tuberosity and from its attachment to the head, and removed in practically one piece with the underlying periosteum. The cavity in the head was then scraped thoroughly with a stout curette, and a small sequestrum surrounded by altered blood clot was removed. The surrounding shaft of the bone and the greater tuberosity presented a slightly eroded appearance, but was otherwise practically normal. The cavity in the head was then widened, so that it presented a perfectly flat surface, and a piece of the deltoid was cut away from the anterior surface of the muscle, leaving the superior part attached to the clavicle, and this muscle flap was then placed in the cavity to fill it, and sutured there by stitches passed through its upper surface. The remainder of the wound was closed with plain catgut, using running horse-hair stitches in the skin. A small rubber tissue drain was placed down to the region of the bone cavity from the top of the transplanted flap of the deltoid.

The operative diagnosis most likely seemed to be some form of bone cyst resulting from his typhoid. The pathological report by Dr. Elser gave the correct diagnosis.

*Pathological Report* (Dr. Elser).—Cavernoma of bone. Specimen consists of a shell of bone removed from the outer face of the head of the humerus. It measures about 8 by 4 cm., presents a relatively smooth outer surface, with low trabeculae projecting from the inner surface. The interval between this shell and the bone proper was filled with bloody material. The face of the bone proper, forming the inner wall of the cavity, showed a small circular depression filled with what appeared to be necrotic material.

Microscopic examination of this material shows the picture of an organizing blood clot. In a few areas the cells are rather atypical, arousing the suspicion of a sarcomatous transformation. Other sections show the appearance of a cavernoma. Considering all the factors in this case we are led to regard it as one of cavernoma in bone, with organization of extravasated blood.

It is probable that the angiomatica so far reported represent three distinct types of tumor formation:

1. The cavernomata which are solitary and are represented by the tumor in the case reported in this paper, and by the cases of Virchow, Toynbee, Schuh, Verneuil, Schöne, Travers, Gerhardt, Muthmann, Ehrmann, Zajackowski, Neuwerk, Birch-Hirshfield, Kauffmann, Stanley, Moltrecht, Lucke, Peau, and Robin, etc.

2. The angiomatica which are multiple and involve the bone and

## HÆMANGIOMA CAVERNOSUM OF BONE

this time he also had thrombosis of a number of cutaneous vessels in the shoulder region. No venereal history.

His family history contained only one interesting fact, his father had a bony tumor removed from his right humerus near the shoulder at fourteen. This tumor was said to have been bony with a blood clot in it. So far as his father knew there was no microscopical report.

The examination was negative, except for the right shoulder region. The right deltoid was more prominent and the whole deltoid region seemed to bulge more than the opposite. There was tenderness over the upper end of the humerus not definitely localizable to any one spot, but more or less diffuse over the whole region of the head. The whole upper end of the right humerus seemed larger than its opposite and there was an irregular mass, hard in character, attached to the upper end of the bone. There was distinct crepitation in the joint and pain in the joint when the arm was abducted against resistance.

An X-ray picture showed a tumor mass composed of a bony shell with bony trabeculæ dividing it into numerous cyst-like compartments which occupied the upper end of the humerus from the head well down to the deltoid attachment. The tumor seemed to spring from the outer surface of the bone, and except for the intertrochanteric region, did not seem to involve the shaft.

The preoperative diagnosis was a tumor of bone, possibly a myxochondrosarcoma, or some form of bone cyst possibly of typhoid origin.

On January 11 I operated upon the shoulder through a six-inch incision over the anterior aspect of the deltoid muscle extending from the clavicle to below the attachment of the deltoid muscle. The anterior fibres of the deltoid muscle were split, and in doing this, the anterior branch of the circumflex nerve was divided and the two ends were caught and retracted, exposing the swelling which extended from the attachment of the deltoid muscle upward along the bicipital groove to the region of the top of the great trochanter, and then bulged outward on the outer aspect of the bone under the muscle. The muscle tissues were carefully reflected away from the outer edge of the bicipital groove and with a sharp osteotome the whole swelling was cut away from the underlying cortical bone. When this swelling, which was covered by a thin shell of bone, was opened, about one and a half ounces of straw-colored, slightly mucoid fluid escaped. This bony shell, which was lined by a mass of coagulated slightly altered blood, was then turned back exposing the shaft of the bone. In the region of the epiphysial line there was





FIG. 3.—High power view of the same field to show the character of the walls of the vascular spaces.

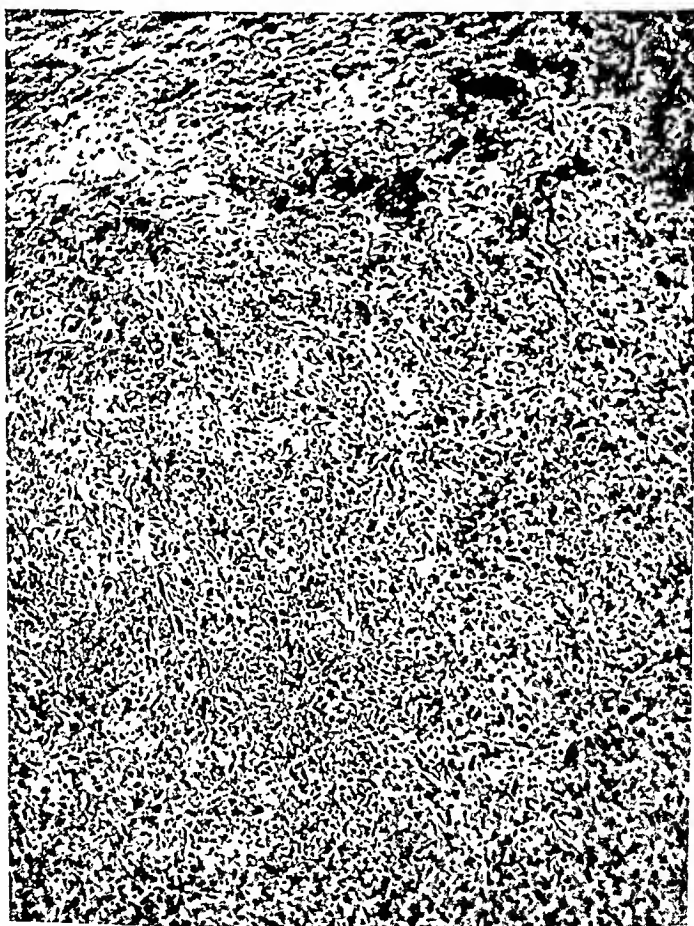


FIG. 4.—Low power view of the organizing blood clot shown in Fig. 2.



FIG. 1.—X-ray of tumor.



FIG. 2.—Low power view of the angiomatous tissue. Note the large vascular spaces. In the lower portion of the picture is seen the blood clot in varying stages of organization.



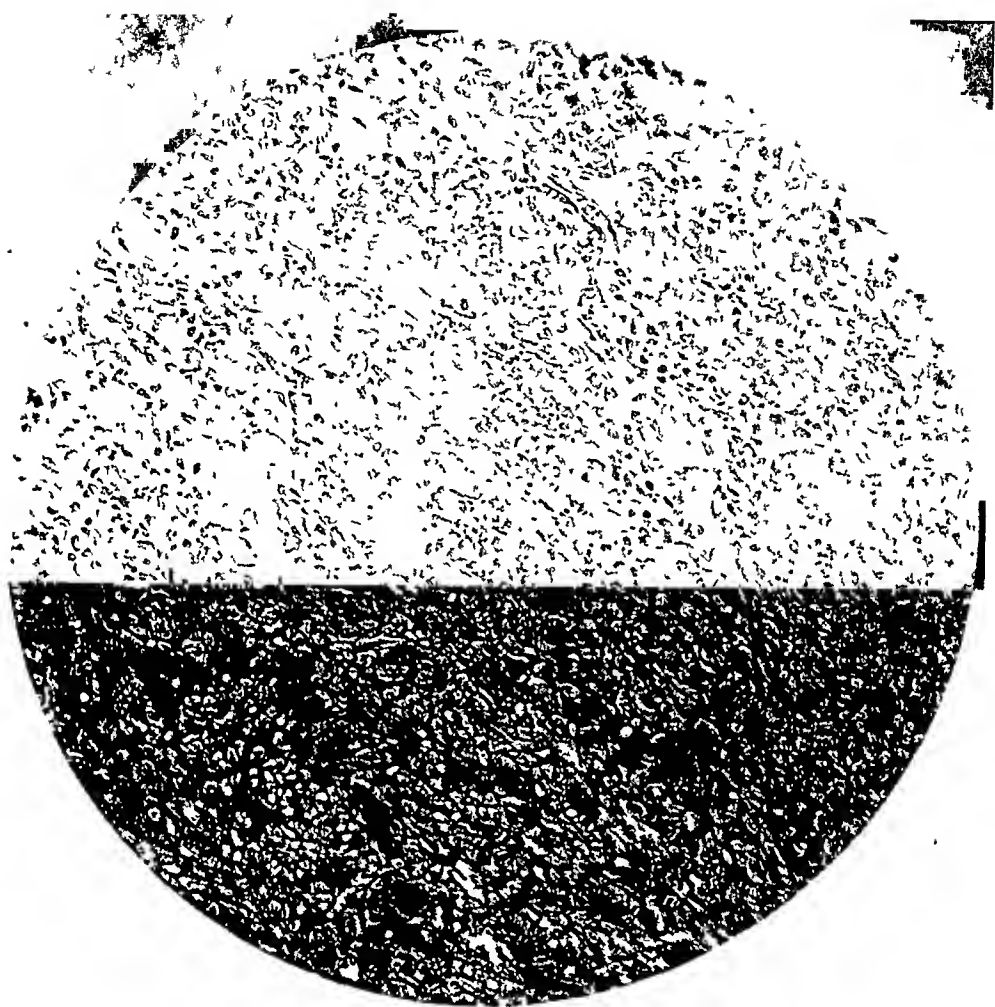


FIG. 5.—High power view of a section of Fig. 3, to show the large mononuclear cells with deeply staining nuclei which aroused Dr. Elser's suspicions as to the character of the tumor. (See Dr. Elser's report for other details )

above given, and it would be extremely valuable could we have seen the X-ray plates taken during the attack two years ago. Unfortunately they were not to be found.

The clinical diagnosis is, as a rule, difficult if not impossible. In so far as I know, my case is the only one in which there was an X-ray picture of the tumor. There is nothing in the picture which would suggest the diagnosis. In fact, one could not say from the X-ray picture alone what the tumor might be. Comparison of a number of such pictures and a careful study of a group of these cases may show diagnostic radiographic evidence which is not now possible.

Schöne believes that the bleeding which occurs at the operation will help in making a diagnosis. In my case there was no more bleeding than would occur in any operation upon bone near the epiphysial line, and there was nothing in the gross appearance except the large cyst-like spaces filled with blood clot in various shapes of organization which would suggest the tumor. It is possible that one may find these tumors in three different types or stages, *i.e.*, (1) when they are richly vascular and will bleed freely at operation, for example the cases of Peau and Moltrecht; (2) when they show large cyst-like spaces filled with organizing blood clot, as in my case; and (3) when they may show various stages of ossification as shown in Lucke's case and which Von Recklinghausen called an ossifying angioma, or angiomatous osteoma.

The diagnosis must eventually rest upon the microscopic picture of the tumor. In the case here described the pictures from various fields showed distinct differences, and had only that portion of the tumor which showed organizing tissue alone been studied, the real condition might readily have been overlooked.

The literature is replete with vascular tumors in bone. The probable cases of angioma classified according to the bone involved are: Femur—Nauwerk, Schleich; metacarpals and phalanges—Schuh, Birch-Hirshfield; clavicle—Travers; pelvis—Cruveilhier; vertebra—Virchow, Gerhardt, Muthmann, Saltykow, Kauffmann; tarsal scaphoid—Verneuil; bones of the skull, lower jaw—Stanley, Moltrecht; upper jaw—Lücke, Peau, Robin; skull, parietal bone—Virchow, Toynbee, Ehrmann, Rokitsky; occipital bone—Cruveilhier, Zajackowski, Schöne (who mentions articles by Djaknow and Callozi to which he did not have access). Ziegler mentions a microscopic section of an angioma from the skull but gives no details.

About a month after the case was shown (April 15, 1916), following some strenuous efforts at tennis, the shoulder again

the viscera, represented by the cases of Virchow, angioma of the vertebra with cavernoma of the liver, by Cruveilhier's both cases, and in the case described by Saltykow. The cases in this second group differ in their extreme vascularity and in the multiplicity of the lesions from that described in the first group.

3. By that unusual case reported by Symmers as multiple primary hæmangio-endotheliomata of the osseous system.

The angiomas in the bone originate in close relationship to the epiphysial line or to the centre of ossification or near the fissures in the skull. It is difficult to distinguish from the descriptions in the literature which tumors are of periosteal and which are of central origin, but the latter type predominates. One may accept as periosteal the tumors in the skull observed by Virchow and Toynbee. Those of central origin are the ones described by Schuh, Verneuil, Travers, Gerhardt, Muthmann, Ehrmann, Zajaczkowski, Schöne. The case here described was evidently of central origin arising near the epiphysial line about midway between the tuberosities.

The histological picture is quite variable, ranging from richly vascular tissue to poorly vascular cyst-like tumors with large spaces filled with organizing blood clot which may show areas of ossification.

The tumor here described did not in its gross appearance differ materially from some of the described forms of bone cyst, especially those containing blood clot. The thorough histological investigation of the wall of the cavity by Dr. Elser determined the diagnosis which could not have been made otherwise, and would have been missed entirely if only a portion of the tumor mass had been examined, for some sections merely showed organizing blood clot with a cellular picture rather difficult to distinguish from a possible sarcoma, while the true angiomatous tissue lay close to the outer shell of bone and the bony trabeculæ (see microphotographs).

The clinical picture is likewise variable. As a rule the tumor grows slowly, producing symptoms especially in the vertebra and skull by pressure upon the surrounding structures, does not pulsate except in rare cases and then only when it has broken through the bony shell. These tumors as a rule are single and show no tendency to metastasize, and in the cases thoroughly removed do not recur locally.

The single predominant feature of the case here described was pain which occurred in recurring attacks and up to the last attack was relieved by salicylates and baking. The enlargement of the deltoid, the doctor thought, occurred only with the last attack. It is difficult to understand the disappearance of this pain under the treatment

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## HÆMANGIOMA CAVERNOSUM OF BONE

became painful and motion became distinctly restricted. An X-ray picture at this time showed a nodular growth toward the inner aspect of the head which looked like exostoses or recurrences of the tumor growth.

On April 17th the joint was reoperated upon and a mass of exostoses found along the bicipital groove. These were removed and at Dr. Elser's suggestion pieces of bone and overlying soft tissue in the region of the previous growth were removed for microscopical examination. There was no evidence of recurrence at the operation and the condition found was regarded as inflammatory exostoses due to the trauma of the previous operation or to the stretching of the scar tissue by the exercise in question.

Dr. Elser's report of the tissue removed at the second operation, April 17, 1916:

The specimen consists of several pieces of bony and soft tissue removed from the upper end of the humerus. The material is divided into two portions, *A* and *B*. *A*, two pieces of soft tissue from the seat of the original growth and a portion of the bony wall from the same location. *B*, two pieces of osteophytes arising from the opposite side of the bone. The material consists of material removed from the cavity in the head of the humerus at the previous operation, and of portions of the exostoses projecting from the head of the bone on each side of the groove of the biceps tendon.

Microscopic examination of the bony structures shows them to consist of cancellous bone. Microscopic examination of tissues from the cavity referred to above shows connective tissue with islands of round-cell infiltration surrounding foreign body giant-cells, and scattered here and there, cells containing blood pigment. No evidences of a tumor process could be found. Diagnosis: Exostosis of the head of the humerus.

His subsequent history is uneventful. There are still exostoses forming in the region of the bicipital groove which I believe account for the little residual pain which occurs after violent exercise.

X-ray plates made at frequent intervals have shown no recurrence of the tumor.

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bone abscesses develop variously. They may be small or may occupy nearly all the shaft of the long bone. They cause no definite sequestrum."

Brodie's abscess, the chronic circumscribed abscess of the bone substance, is readily recognized in the röntgenogram as a translucent area surrounded by the shadow of dense bone (Fig. 1). In the region of the abscess this productive osteitis may cause much thickening of the bone, and often associated with it is a localized periostitis.

The medullary abscess, like acute suppuration of the bone marrow, cannot be recognized as such, röntgenographically. The röntgen ray appearance is that of an osteoperiostitis (Fig. 2) or of a bone that has been the seat of an osteomyelitis (Fig. 4). Although the diagnosis therefore cannot be made by the röntgenographer, it can be made by combining his findings with the clinical observations. Perhaps, however, a suggestion for a röntgen ray diagnosis can be found in the character of the osteitis as it appears in the picture: when the abscess is medullary there is sometimes but little external thickening of the bone; the osteitis then spreads centripetally, encroaching upon and sometimes in one or more places completely obliterating the medullary cavity (Fig. 2). This internal thickening is by dense dry bone. Such an osteitis or osteoperiostitis, when, by its appearance or otherwise, syphilis can be excluded, and when there is no evidence of necrosis or cortical abscess, would justify the röntgenographer in suggesting the possibility of pus in the marrow cavity.

The chronic medullary abscess of a long bone, uncomplicated by any active process, is not associated with fever, as far as my experience indicates.

The sole symptom is severe, more or less continuous pain in the affected portion of the extremity. This pain may radiate, as from the arm into the forearm or from the thigh into the leg. It may thus be mistaken for a neuritis; and for "neuritis" or "rheumatism" these patients may be treated for a long time before their condition is recognized.

The sole constant objective finding is localized bone tenderness. There may be palpable bone thickening.

The röntgenographic appearance is, as mentioned, that of an osteoperiostitis or that of a former osteomyelitis.

*This triad—severe pain, localized bone tenderness, and the röntgen picture—make the diagnosis of chronic medullary bone abscess, if the patient is afebrile.* The same pain and tenderness are produced by a

# CHRONIC MEDULLARY ABSCESS OF THE LONG BONES

ITS CLINICAL AND RÖNTGENOGRAPHIC FEATURES: ITS TREATMENT BY SIMPLE TREPHINING

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A SEARCH of the literature in English, German and French, including the standard works on general pathology, surgical pathology and surgery, revealed but few references to any type of chronic bone abscess (excluding the suppurative process associated with bone necrosis) other than that of the bone substance itself (cancelli), generally known as "Brodie's abscess." Very few of the authors indicate—and some of them only vaguely—that there also may occur a chronic accumulation of pus, large or small, wholly within the medullary cavity. Indeed, Bowlby.<sup>1</sup> says: "Chronic abscess is never met with in the shafts, but always in the cancellous tissue of the epiphysal ends." This statement is quite incorrect, not only because it denies the occurrence of medullary abscesses, but also because the so-called Brodie's abscess ("epiphysal abscess," Cruveilhier), although most often located in or near an epiphysis, is also sometimes found in the shaft.

In contrast with Bowlby's utterance it is only fair to quote here the clearest anatomical description of chronic medullary bone abscess that I have succeeded in finding: "There is a form of osteomyelitis . . . which is fairly entitled to the term chronic, although in its main characteristics it presents the same pathological features as the acute form. . . . It also differs from the acute form in that it is associated with a chronic osteitis of the compact bone, and an osteoplastic periostitis which leads sometimes to a very considerable thickening of the shaft of the bone over a greater or less area and occasionally to a considerable increase in length. Sometimes there occurs an accumulation of pus, which may vary from a few drops to several ounces. This pus may be confined to the region of the medulla, or it may form a distinctly circumscribed abscess in or near the epiphysis of the bone. The latter is the commonest form, and such abscesses are frequently known as Brodie's abscess."<sup>2</sup> It is not clear whether Mumford<sup>3</sup> also meant to describe a medullary pus accumulation, or an extensive abscess of the bone substance itself, in the following: "Chronic localized

surgical division" of the hospital, where he was operated upon July 29, by Dr. Buerger. A four-inch incision was made over the mass anteriorly. The periosteum was found much thickened. The projecting bone mass was removed level with the rest of the shaft. Only dense, dry bone was encountered. The muscles and skin were sutured without drainage. Primary union. There was no relief of pain. On August 6 the patient was discharged: "Chronic osteoperiostitis of femur; unimproved," and referred back to the dispensary. Except for a slight elevation the day after the operation, the temperature had not been above 99° throughout his stay in the hospital.

Persistence of the pain made me feel more sure of what I had thought before, that there must be some pus in the medullary cavity. I had the patient re-admitted to the hospital November 5, 1910, and operated upon him November 9. The periosteum was exposed through the line of the former incision. An osteoperiosteal flap was made and reflected. With the chisel the medullary canal was entered, exposing within it a few drops of thick pus (from which I neglected to make a culture). Some necrotic, but not loosened, bone was removed from the depth. The cavity was swabbed with an iodine solution; the bone flap was replaced; and the fascia and skin were sutured without drainage. Prompt cessation of pain. Primary union. Before operation the blood-count showed 16,000 leucocytes; 67 per cent. polynuclears. November 22: Discharged—"Chronic osteomyelitis of femur, with medullary abscess; cured." There was no recurrence of the pain.

CASE II.—S. C., male, Russian, aged twenty-three, furrier, was admitted to the third surgical service of Mount Sinai Hospital on May 16, 1916. In 1909 he had been shot in the right shoulder, the bullet evidently traversing the humerus and lodging under the skin posteriorly. It was removed therefrom at the Lincoln Hospital, New York. Thereafter sinuses formed in the shoulder region, discharging pus and occasionally small sequestra of bone. On account of these he was operated upon at the Massachusetts General Hospital in 1913 and a piece of the bullet was then removed. After that a sinus would occasionally form, discharge a small bone fragment and close. At the time of admission there was a remnant of such a sinus, then only skin deep, which had appeared at the upper angle of the anterior incision of the last operation, had discharged scantily and was closing rapidly. The patient complained of severe, fairly constant pain in the arm, referred especially to the junction of the upper and the middle third, and radiating into the forearm.

chronic abscess of the bone substance (Brodie), but, to repeat, the röntgenographic appearance will distinguish it.

The clinical course of such a medullary accumulation of pus is essentially chronic. It would seem that it causes neither fever nor prostration. It does cause, or, at any rate, has associated with it, a productive ostitis or osteoperiostitis, which is, perhaps, a reactive rather than a bacterial inflammation. Prompt cessation of pain and tenderness follows the simple evacuation of the pus. There appears to be little or no tendency to bone necrosis; and chronic medullary abscess must not be confused with "ostitis interna" as described by Billroth or the "central necrosis" of Keen, although it may have the same origin. Nor, it seems, is there a tendency to perforation. Of the characteristic typhoid "shirt-stud abscess," a cortical process which, perforating, spreads under the periosteum, Keen<sup>4</sup> says, however, "In this form there is a localized abscess outside the tibia . . . and another similar one under the outer layer of the bone or even in the medullary cavity, the two abscesses being connected by a cloaca or sinus through the wall of the bone . . ." Whether the medullary suppuration in such a case is primary or an extension from the more common cortical typhoid abscess I would not undertake to say; but I have not found recorded any case of pure medullary abscess of typhoid origin.

CASE I.—J. F., male, Austrian, aged twenty-one, clothing cutter, was under my observation continuously during the summer and fall of 1910, when I was in charge of one of the surgical out-patient departments of Mount Sinai Hospital. Since November, 1909, he had had pain in the middle of his left thigh, at first dull and intermittent, but soon becoming continuous and severe and radiating into the leg. There was no functional disturbance, atrophy, fever, or sensory change. In the mid-thigh anteriorly was a palpable, irregular, slightly tender thickening of the femur. Röntgenograms showed that this was produced by an osteoperiostitis, the bone growth extending not only peripherally but also centrally, at one area almost obliterating the medullary cavity. There was no reddening of the skin. The integument and muscles could be moved over the thickened bone.

The family and previous history were negative; syphilis was excluded by the Wassermann test and by the failure of persistent specific treatment; and the etiology was not discovered. Large doses of aspirin gave no relief.

On July 23, 1910, I transferred the patient to the "second



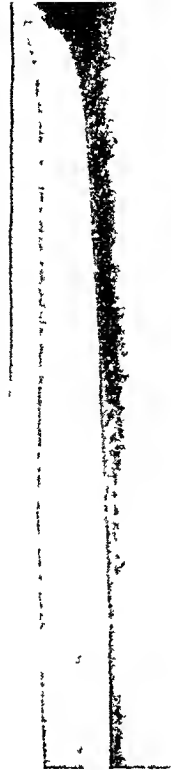


FIG. 1.—Cortical abscess of the shaft of the tibia.



FIG. 2.—Case II. Before operation. Osteoperiostitis with chronic medullary abscess of the humerus. Note the bullet fragments.

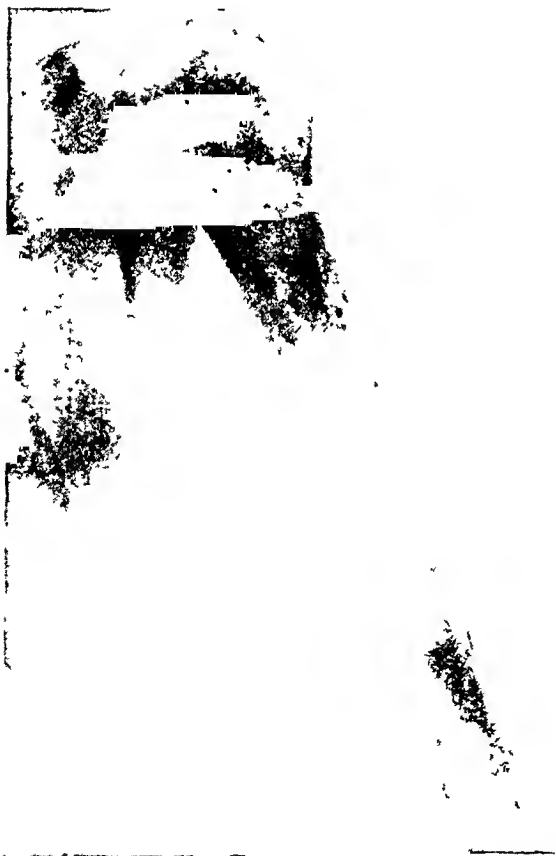


FIG. 3.—Case II. Four months after operation. Note that the drill hole has filled with bone and the periostitis has disappeared.



FIG. 4.—Case III. Chronic osteomyelitis of the humerus with medullary abscess.

quickly closed, except at the site of the drain. When the patient was discharged from the hospital, two weeks after operation, this opening was but a small granulating wound, discharging a little pus. It soon contracted to a minute sinus, leading to the bone and discharging very little; and by September it was solidly closed and has not since reopened. A röntgenogram on September 25, four months after operation, showed the drill hole filled in with bone, and no evidence of the former periostitis (Fig. 3).

My experience with Case I suggested to Dr. Lilienthal the diagnosis and plan of treatment in the following case, which had been under observation on his service for eight days:

CASE III.—I. B., male, Russian, aged twenty-three, hospital porter, was admitted to the first surgical service of Mount Sinai Hospital, November 15, 1916. In 1906 he had been operated upon for osteomyelitis of the left humerus developing after a fall. The wound continued to discharge and four subsequent operations were performed (1906-1908). Thereafter he was well, had no sinus, and was free from pain until two weeks before admission. For a fortnight he had had much pain in the outer portion of the left arm, radiating to the elbow and to the pectoral region, and worse at night.

There was no fever. Movements of the extremity were unimpaired. The arm was of normal contour but bore five large scars. There was decided bone tenderness below the apex of the deltoid, its maximum at the junction of the middle and the lower third of the humerus. The left epitrochlear and axillary glands were palpable. Röntgenograms showed the familiar picture of a healed osteomyelitis with no evidence of sequestrum or abscess (Fig. 4).

*Operation* (Lilienthal) (November 27).—Under nitrous oxide narcosis the bone was exposed at the site of maximum tenderness by a 2-inch incision over the outer aspect of the arm. Through the much thickened cortex an opening the size of a dime was made into the marrow cavity with a gouge, and a half ounce or more of thick, buff-colored pus escaped under tension. A piece of gauze was laid between the muscles, but not in the bone, and the wound was otherwise closed with sutures. The pain ceased immediately. The gauze drain was removed on the fifth day, and the wound speedily closed. The patient was discharged December 12 and at once returned to his work, well. Cultures of the pus yielded no growth. The temperature throughout was not above 99°, except the day following operation (100°).

There was no fever. There was no deformity of the arm, except the scars, and no palpable irregularity or thickening of the humerus. The shoulder and other movements were perfect. There was neither atrophy nor sensory change.

Röntgenograms revealed the presence of minute bullet fragments scattered about the upper portion of the humerus, which showed an osteoperiostitis, with no evidence of necrosis. The periostitis was but slight and chiefly in the deltoid region. The ostitis was in the middle third of the shaft. Here there was slight thickening but the bone growth was chiefly centripetal, in two places obliterating the medullary canal. The head of the humerus appeared quite normal (Fig. 2).

Because of the radiation of the pain, the exquisite tenderness when the brachial nerves were pressed against the humerus, and the röntgenographic finding of the minute bullet fragments, it was thought by some that irritation of the nerves by these fragments was the cause of the man's suffering. I noted, however, that finger pressure against the outer aspect of the bone, just below the deltoid, elicited the same tenderness, and that compression of the nerves between the muscles was not painful. I concluded, therefore, that the lesion was a chronic medullary abscess of the humerus, and in this diagnosis Dr. Moschowitz concurred.

*Operation* (Brickner) (May 19).—The humerus was exposed through a  $2\frac{1}{2}$  inch incision on the outer aspect of the arm, commencing above over the lowest portion of the deltoid. The periosteum was found thickened. The shaft was entered with a Hudson drill a little below the deltoid apex, but at this point the bone was found solid, the medulla obliterated. A second drill hole was made a little above this (after incising the tendinous deltoid), the marrow cavity was entered, and several drachms of thick, creamy pus welled out. This came down from above, and a large probe passed into the cavity went up into the head of the humerus. At the lower end of the cavity curetting revealed scanty granulations. The canal was wiped out with iodine-wet gauze. (In another such case I shall resist the temptation to investigate the extent and the lining of the cavity.) The two almost contiguous drill holes were made into one measuring about  $3 \times 1$  cm., and just into the mouth of this opening was placed a rubber tube drain (stitched to the muscle). The wound was otherwise closed by sutures. Smears of the fresh pus showed no organisms and cultures no growth.

It was confidently predicted by some of my colleagues that the bone would never heal until the entire pus-containing cavity was laid freely open. Although the wound became infected it



Case III, was immediately relieved and was restored to full activity in two weeks! So, also, was Case I.

Even in acute osteomyelitis it is not always necessary to remove bone over the entire length of the suppurating medulla. If it appears viable and sound, several inches of the shaft may be left undisturbed after evacuating its medullary pus with a spoon.

After trephining a chronic medullary abscess the cavity probably fills with granulation tissue. Such filling is apparently not necessary to the healing over of the soft parts, however, for in Case III the wound was definitely closed in ten days or less.

In selecting the spot for draining the bone the point of maximum tenderness is the best guide. The röntgenogram is helpful in indicating, sometimes, a level where the medullary space would be found obliterated. The technic adopted by Lilienthal appears to me the wisest, viz., to introduce nothing into the cavity except the single instrument by which it is opened; to insert a small gauze, rather than a tube, drain down to but not into the bone, with which to provide for the escape of any remaining pus, of blood and of serum; and to remove this, preferably without replacement, as soon as the discharge has practically ceased.

I wish to thank Dr. L. Jaches, röntgenographer of Mount Sinai Hospital, for these röntgenograms, and Dr. Samuel K. Levy of the house-staff for his assistance in abstracting the case histories.

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## CHRONIC MEDULLARY ABSCESS OF THE LONG BONES

These chronic medullary abscesses are probably most often, perhaps always, residual from an osteomyelitis, as typified by Case III. Perhaps, however, they may develop sometimes from a pure infection of the bone marrow, either hæmatogenous or, as from a bullet or a surgical instrument, direct. This hypothesis is suggested by Case I and Case II, in both of which, however, there had also been some necrosis of the bone. In his explanation of bone abscesses as a development of circumscribed osteomyelitis, Hildebrand<sup>5</sup> says: "If the medulla in the centre of a long bone is affected in a limited area there is no opportunity for sequestrum formation, for there is no bone there; there forms then simply a cavity lined with granulations, with or without pus" (translation). If there is no opportunity for bone necrosis (compare Case I) such a condition cannot be regarded as even a circumscribed osteomyelitis, *as we use the term clinically*, but would be what I have just suggested hypothetically, purely a marrow infection—an osteal myelitis.

Whether these chronic pus accumulations always eventually become sterile, and the condition always afebrile, I do not know. In a recently observed subacute case in which the signs and symptoms suggested a medullary abscess, but in which there was fever, I found not merely a large amount of pus in the marrow cavity, but an active and extensive "osteomyelitis."

If the pus is sterile the pain seems best explainable by the pressure under which the fluid is confined. This, rather than the osteoperiostitis, probably also explains the tenderness which, like the pain, disappears promptly after the escape of the pus.

In spite of preconceived notions, evacuation of the chronic medullary abscess through a drill or trephine hole in the bone seems to me the method of choice, and the excellent results in Cases II and III support this contention. Admittedly such early healing may not always follow. As a result of secondary infection, or perhaps from the awakened activity of dormant organisms, continued suppuration or a localized bone necrosis may develop. But if these do not subside spontaneously they can be dealt with secondarily by an operation probably much less extensive than a primary exposure, by bone removal, of the entire pus cavity. Such a procedure in Case II would have meant chiselling away the bone into the head of the humerus itself—a rather formidable operation that would have entailed prolonged hospital care and loss of employment, and perhaps much permanent disability. By the simple trephine drainage this patient, like

would be to make the patient comfortable, straighten and fix the limb without attempting to reduce the fragments by much extension, counter-extension, rotation and manipulation.

The result in such cases would be shortening and perhaps a lack of correspondence in planes and axes of the two segments, yet the functional result might be good in spite of the deformity.

On the other hand, under an anæsthetic to push, pull and manipulate or to do an open operation and put in a bone splint, or metal plate, would probably give a perfect functional and anatomical result, but the danger to life would be increased. Yet the patient is usually willing to incur a slight risk to his life for the sake of getting a good and useful member and he is quite justified in taking the risk. So, in every case, to the conscientious man, it is a question of nice surgical judgment, and the surgeon should give the patient the same advice that he would take if he were in the patient's place.

In fractures of the *shaft* good results can sometimes be obtained by means of Buck's extension, Hodgen's and N. R. Smith's methods. Wires, nails and screws alone are not as desirable as plates, bands, bone-splints, or interlocking.

My first choice of means to hold the fragments together was silver wire, which I soon abandoned for iron wire, which I found cheaper and stronger and no more likely to be followed by infection. In an article entitled "The Operative Treatment of Fractures—Especially of the Long Bones," published in the *Trans. Med. Society of Va.*, 1906, and *American Journal of Medical Sciences* for March, 1907, I referred to over one hundred cases I had operated on, in most of which wire was used, and the various methods of using wire were shown by drawings.

Since then, with increased experience and observation, I use less wire and more of other means for maintaining coaptation. For oblique fractures the steel bands of Parham and Martin impress me as being superior to wire. They are very strong and are applied without drilling holes in the bone.

The metallic plates most commonly used are those of Lambotte and of Lane. Good results are reported from the use of both. I have not used Lambotte's plates because their size, covering something like one-third of the circumference of the bone, impressed me as more objectionable than Lane's plates which are attached to a much smaller surface. The Lambotte plate, however, holds the fragments more securely and there is less need of an outside splint when it is used.

The Lane plate gives good results in suitable cases and when properly applied. Like all other new things—new medicines, new instru-

## THE TREATMENT OF FRACTURES OF THE FEMUR, ESPECIALLY IN THE OLD\*

BY GEORGE TULLY VAUGHAN, M.D.  
OF WASHINGTON, D. C.

FRACTURES of the femur are, of themselves, always serious injuries, and differ from fractures of the skull, which are serious only in proportion to the damage done the brain or vessels. Of all the bones in the body, this is the one whose fracture, independent of surroundings or adjacent structures, is followed by the most serious results—whether it be neck, shaft, or extremity.

Fractures of the *shaft* are most frequent during the strenuous period of life, say fifteen to forty, while those of the *neck* are much more frequent after the age of forty, and especially in old women. Fractures of the neck occur occasionally in young children. For years the opinion has prevailed that the mortality in the old is very high and that the only possible chance to save the patient's life is to adopt some form of treatment that will not confine the patient to bed.

The mortality is high under any method of treatment, not necessarily because of confinement to bed, but chiefly owing to the fact that the femur is the great marrow bone of the body, containing more fat than any other bone; therefore the patient is more likely to have fat embolism than after fracture of any other bone. I believe the most frequent cause of death is thrombosis with embolism either from fat or blood-clot, and it is liable to occur in any patient whether operated on or not. How much infection has to do with it is not known. In some cases it can be traced to a probable infection, in others there is no such probability. No doubt many of the cases of pneumonia, of arrested renal function and of coma are due to emboli in the lungs, the kidneys, or the brain, as the case may be.

The question of *treatment* is often a difficult one to settle. The surgeon wants to select the method which is least dangerous to life, and at the same time the one which will give the best results in the broken bone, functionally and anatomically. The safest method, so far as life is concerned, is often the one which would inevitably give poor functional and anatomical results. Perhaps the method safest to life

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\* Read before the Southern Surgical Association, December 11, 1916.

thick enough to fit tightly into the medullary cavity, is removed from the bone a short distance from the site of fracture but through the same wound and then inserted into the medullary cavity of the two fragments. This is suited for transverse fractures and prevents overriding, but not bending, which is prevented by a plaster-of-Paris cast.

The first method is used in oblique fractures.

I have had no experience in the use of the Codivilla-Steinman method of extension by means of nails or skewers driven into or through the bones.

Fractures of *the neck of the femur if impacted*, with little or no deformity, should be treated by plaster of Paris from chest to toes on the affected side with the limb in the normal position of extension parallel with its fellow.

Fractures with *separation* of fragments should be treated by the Whitman method of abduction. Then if the Roentgen ray shows the reduction unsatisfactory open operation should be done, unless there are contra-indications, and the fragments fixed in some manner which seems best. I have had the best results with steel screws, 3 to 4 inches in length, passed through the base of the trochanter major and the femoral neck into the head of the bone. I have used nails but think they are inferior to screws.

*Ununited fractures* of the neck should be treated in the same way. Plaster of Paris should be applied from chest to toes in all cases, and kept on or renewed for a period of about three months, and no weight should be borne on the affected side for at least 4 months. I usually tell my patients with fractures of the *neck* that they may walk again after from 6 to 12 months. No one knows definitely when a broken femur will unite, and it is best to be on the safe side. Patients are quite comfortable in the plaster and should be frequently turned over on either side or on the face to prevent hypostatic congestion, and can be brought up in a slanting position by raising the head of the bed.

ments, new methods, new fashions—it has been used by men of poor judgment in unsuitable cases and hence has received much adverse criticism—some of it by men who have never used it and are not competent to criticise it. It should not be used by a slovenly surgeon or one who does not practise, or have the facilities for ensuring, the strictest asepsis. I have used the Lane plate in a number of patients with fine results. In some I have had bad results, but it would hardly be fair to lay the blame on the plates. For example, in a compound comminuted fracture of both bones of the forearm sent to hospital for amputation, I decided to try to save the limb and applied plates to the broken bones. The patient did well for two weeks, but left the hospital against advice, had a bad infection and finally suffered amputation of the forearm. However much room there may be for speculation as to what might have been, no fair-minded man would condemn the Lane plate for a failure to cure this case. Patients whom I have plated years ago are going around attending to their business and would not know of the presence of the plates had they not been told.

An instructive case is reported by the Vander Veers of Albany, in the *Transactions of the American Surgical Association* for 1914: A man with both femurs broken practically alike was treated by reduction, a Lane plate on the right femur and plaster of Paris on the left side. The final result showed quicker and better union on the side of the Lane plate. The inevitable conclusion from this one case is that the plate properly applied does *not* cause *delayed* union. Many others could be cited which confirm this opinion. We know that delayed union and ununited fractures were not uncommon in the days before open operation came into use. Warren reported a case of complete absorption of the humerus after a fracture.

I do not perform open operation or put foreign material in the tissues unless I think the indications therefor are clear and convincing.

Frequently after exposing the fragments by open operation they can be adjusted in such a manner as to stay in place without other aid than that of external splints. For some years I have been using two methods to avoid the use of foreign material in the tissues, one of which I have never heard of any one else using, and that is to insert the sharp end of one fragment into the medullary cavity of the other until firm fixation is obtained without shortening of the bone. Sometimes in order to accomplish this, it is necessary to shape the fragments to some extent with cutting forceps. The other method is to use an intramedullary splint of bone, preferably taken from the bone operated on. In case of the femur a fragment an inch or an inch and a half long and

out rotation of the fragment is equally rare, only two cases having been reported (Rondeau, Ombredanne). In this type of injury the calcaneo-malleolar ligaments are ruptured, allowing the foot to be displaced forward, while the astragalomalleolar ligaments remain intact. The posterior fragment when the dislocation is completed rests upon the retro-articular surface of the os calcis. The posterior fragment is, however, not rotated on its axis.

Displacements of the posterior fragment with rotation upon its axis are more frequent. The fragment may be so rotated that the articular surface of the astragalus rests upon the tendo achillis. The fragment may be displaced to the inner or outer side of the tendo achillis and come to rest behind either the internal or external malleolus.

The following history deals with a fracture through the neck with displacement with rotation of the posterior fragment. The line of procedure followed in this case can be used to advantage in all fractures of this type.

G. W. B., twenty years of age, was admitted to the Presbyterian Hospital on the service of Dr. Dean Lewis, May 14, 1916. He stated that ten days before he had sprained his ankle. When the accident occurred he was running down the side of a ditch trying to catch a baseball, and the spike of his shoe caught on a tin can, throwing him forward from the ankle. He was then taken to a local hospital, where the fracture was recognized and an unsuccessful attempt made at reduction. The following morning ether was administered and another attempt was made to reduce the fracture dislocation without success. The foot was then immobilized.

Ten days after the accident he was admitted to the Presbyterian Hospital. An examination made at this time revealed a swollen left ankle which was tender. Attempts at movement of the joint were painful. A hard mass could be felt behind the internal malleolus, between it and the tendo achillis and a little to the front of the median side of the latter. This was evidently a displaced fragment of bone. The toes were strongly flexed and the patient complained bitterly of the marked flexion of the toes, which he said caused him much pain. Evidently both the flexor longus digitorum and flexor longus pollicis were stretched over the displaced fragment.

An X-ray picture of the ankle (Fig. 1) revealed a fracture through the neck of the astragalus. The posterior fragment composed mostly of the body of the bone had been forced out of the joint and rotated on its transverse axis so that the articular surface rested upon the tendo achillis. The lower end of the tibia

## FRACTURES THROUGH THE NECK OF THE ASTRAGALUS

BY ALBERT H. MONTGOMERY, M.D.

OF CHICAGO

FRACTURES through the neck of the astragalus were formerly thought to be relatively rare. It is certain, however, that they are more common than the earlier publications dealing with this subject would seem to indicate. Golebriwsky has personally observed 77 fractures of the astragalus and Borchardt saw 12 within a few years.

Fractures through the neck of the astragalus are of especial interest, for the fragments may be displaced in a number of different ways, and the functional integrity of the ankle-joint may be seriously interfered with unless proper surgical procedures are instituted early.

Fractures through the neck may occur without any displacement of the fragments. In such instances the ligaments may remain sufficiently intact to hold the fragments in place. Fracture of the neck without displacement is rare. Baudet, in his recent monograph on fractures of the astragalus, found but five of this type, one being reported by Meniszez, two by Louis and two by Mauranges.

Displacement of one of the fragments is the rule and usually it is the anterior one. Most commonly this fragment is displaced upward and forward, overriding the posterior fragment, the scaphoid or cuboid. In this form of displacement, the fragment can usually be felt beneath the skin in front of the ankle-joint. In a few cases the displacement has been downward, the anterior fragment then being found beneath the posterior. The prognosis in cases in which the anterior fragment is displaced is usually good. As a rule the functional result is good even when reduction is not possible, and the fragment has to be removed.

In a smaller proportion of fractures through the neck the posterior fragment consisting of the body and possibly a part of the neck is displaced. The prognosis of this type of displacement is doubtful from the functional viewpoint. An open operation is usually required to reduce the dislocated fragment, and the injuries of tendons and nerves may complicate the fracture.

Forward displacement of the posterior fragment is very rare, but two cases having been reported, both verified by operation (Morestin and Couteaud). In this type of displacement the posterior fragment had been forced out of the joint and rested beneath the skin in front of the external malleolus. Direct backward displacement with-







FIG. 1.—Showing position of the fragments before operation.



FIG. 2.—Plate showing astragalus five months after operation.



FIG. 3.—Lateral views of feet, showing absence of deformity and line of incision. Taken eight months after operation.

the injury. In 3 cases the posterior fragment has been replaced with good results. In 1 case total astragalectomy was resorted to after reposition of the fragment had proved unsuccessful because of infection. In one case the line of treatment pursued is unknown.

None of the arguments which have been made against the reposition of the fragment are valid. Some have thought that callus formation might interfere with the motions of the ankle-joint. In the cases in which reduction has been attempted no such result has followed. Necrosis of the fragment has also been feared, but even when this fragment is completely separated it can be replaced without fear of necrosis, for it has as many if not more chances for survival than a free bone transplant. Rixford replaced the dislocated fragment in one of his cases and united the two fragments with a silver wire. The result was good and the ankle-joint approached more nearly in appearance the normal one than in the case in which he resorted to partial astragalectomy. Urban secured a splendid result after open reposition of the posterior fragment. Robinson, dissatisfied with the deformity and poor function which followed astragalectomy in his first two cases, replaced the fragment in his third case and secured a much better result.

If the nature of the injury is recognized the fragment can be easily reduced by an open operation. When once in place the dislocated fragment tends to remain in place if the foot is held at right angles. No mechanical means of fixing the fragments are required, for alignment is almost perfect when the fragment is placed back in the joint cavity.

Rixford classifies this as a cleavage fracture. The mechanism is as follows: The foot is held in extreme dorsal flexion as in running down an incline. With the foot in this position, it is caught upon some object and the neck of the astragalus is divided by the anterior edge of the lower articular surface of the tibia. The force continuing exaggerates the dorsal flexion of the foot and the posterior fragment is forced out of the joint.

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projected into the defect resulting from the separation of these two fragments.

*Operation* (May 1, 1916).—Under ether anæsthesia; to replace this dislocated fragment. An incision measuring about four inches in length was made behind the internal malleolus over the displaced fragment. The posterior tibial nerve was torn and the ends were found separated a short distance. The tendon of the flexor longus hallucis was crowded outward and backward by the fragment and was divided in order to render reduction of the fragment more simple. Attempts at reduction were unsuccessful until the tendo achillis was divided. The foot could then be brought into extreme dorsal flexion, and when the foot was in this position the dislocated fragment could easily be replaced. There was no tendency for the fragment to become dislocated, and consequently no attempt was made to fix by any mechanical means the two fragments of the astragalus. An end-to-end suture of the posterior tibial nerve was performed, and the ends of the flexor longus hallucis sutured. No attempt was made to suture the ends of the tendo achillis. A cast was applied and the ankle was immobilized for eight weeks. After eight weeks the cast was removed and the patient was encouraged to use the ankle.

Eight months after operation the patient has practically complete function of the ankle-joint; all motions being practically of normal extent. The toes have never completely recovered, and in Fig. 3, a lateral view of both ankles, some deformity of the toes can be seen. An X-ray picture taken five months after reposition of the fragment would indicate a union of the lower half of the line of fracture. There is a defect in the upper half of the line of fracture, but union has apparently occurred. This statement is based upon findings revealed by manipulation of the ankle-joint.

As far as can be determined by looking over the literature, 18 cases of backward dislocation of the posterior fragment associated with rotation have been observed. Baudet collected 12, Rixford reported 2, Robinson 3, and Borchardt reproduces an X-ray picture of Kohlhardt's case in the *Handbuch der Praktischen Chirurgie*. The one just reported above makes a total of 19 cases.

Partial astragalectomy has apparently been the operation of choice in most of these cases. This operation was performed in 10 cases, with 5 good and 4 unsatisfactory results. In one case the result was unknown. Total astragalectomy was performed five times. Apparently the results following total astragalectomy were satisfactory, but it is difficult to see why this operation should be resorted to when reposition of the fragment is so easy if the patient is seen within a relatively short time after

the patient's distress to this spur. He was then referred to me. I found that the man had a marked condition of weak foot; there was no tenderness or swelling about the heel cords. The spur was evidently an accidental irregularity in the outline of the posterior surface of the os calcis, a condition not infrequently met with. A pair of Whitman flat-foot braces was applied, the

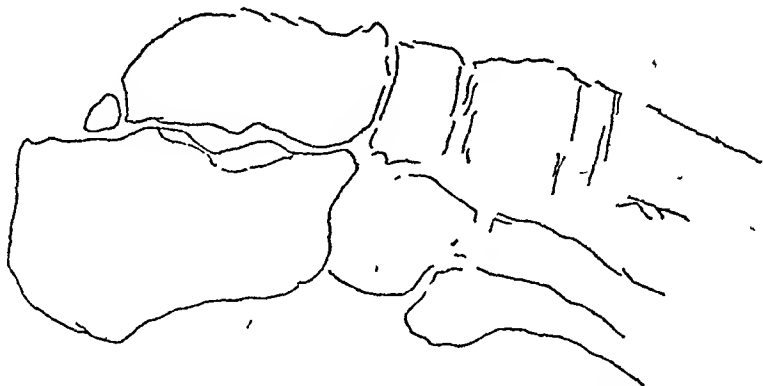


FIG. 1.—L195. Trigonum—separate from the body of the astragalus.

proper shoes and exercises advised, and the man made a rapid recovery.

CASE II.—(Case L340, X-ray series at the New York Hospital for Ruptured and Crippled). Fig. 3 was very interesting. This patient had a fall in which his right foot was injured. The X-ray



FIG. 2.—L35. Elongated trigonum.

showed a dislocation of the right scaphoid bone; also a mass of bone behind and distinct from the astragalus, which was diagnosed as a fracture of the astragalus. An X-ray of the uninjured foot, however, showed an exactly similar bone in back of the astragalus, the so-called os trigonum, and therefore made it extremely probable that the area of bone, regular in outline, behind the right

# SUPERNUMERARY BONES OF THE FOOT

AN X-RAY STUDY

By SAMUEL KLEINBERG, M.D.

OF NEW YORK CITY

(From the Radiographic Department of the New York Hospital for Ruptured and Crippled)

THIS communication is prompted by the comparative frequency with which the writer has observed, in the routine X-ray examination of feet, supernumerary bones as well as marked variations in the outlines of the astragalus and os calcis. The recognition of these conditions is especially important when examining a foot that is the seat of inflammation or that has undergone an injury. Supernumerary bones have been erroneously diagnosed as fractures; and irregularities in outline interpreted as evidence of inflammation.

Some years ago Dwight, in an extensive anatomical study, called attention to the existence of definite accessory bones in the feet and hands, described in detail their usual shape and position, and mentioned that many of these, particularly in the foot, may be readily recognized in radiograms.

In many branches of medicine a physician rarely sees the picture, when sending a patient for an X-ray. He usually accepts the radiographer's opinion and abides strictly by his interpretation. For the orthopædist, however, it is essential to have an accurate knowledge of the radiographic appearance of the foot in order that he may be able to correlate the subjective symptoms with the objective findings.

A brief review of several cases will serve to indicate the practical application of this study.

CASE I.—J. A., male, forty-five years old, was sent to me by his physician for spurs of his heels. The man had for several months been complaining of sensitiveness of his heels, pain in his feet and undue tiredness after moderate exertion. There was no history of any injury, associated illness as arthritis, or venereal disease. Having been treated for rheumatism without relief, an X-ray of his feet was suggested and taken. This showed a sharp spur (see Fig. 16) on the posterior surface of each os calcis at the attachment of the tendo achillis. Though the patient's sensitiveness was on the under surface of the heels, this fact was lost sight of and the presence of the spur influenced the physician to attribute

From these citations it must be apparent that in the reading of X-rays of feet it is necessary to know the variations in shape of the individual bones, as well as the location and shape of the different supernumerary bones.

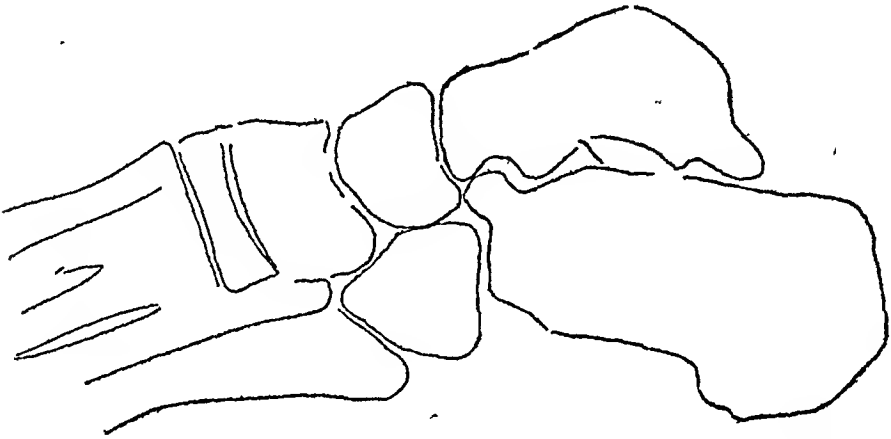


FIG. 4.—L343. Marked projection of posterior tubercle of astragalus. Probably a fused os trigonum.

I am deeply indebted to Dr. Byron C. Darling, radiographer to the New York Hospital for Ruptured and Crippled, for the opportunity to make the study, the results of which are embodied in this article.

Three hundred and fifty X-ray plates of one or both feet were

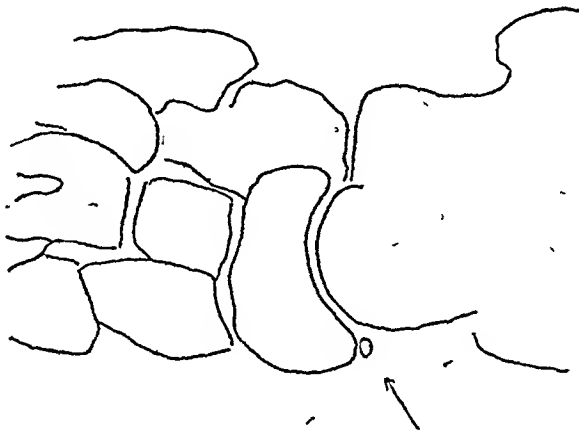


FIG. 5.—L247. Tibiale externum; present only on one side.

examined and of this number 62 showed supernumerary bones. The following table shows their relative frequency:

	Cases	Bilateral	Per cent.
Os trigonum .....	19	6	5+
Os tibiale externum .....	12	4	3½
Os peroneale .....	20	8	5+
Os vesalii .....	4	2	1+
Secondary os calcis .....	7		2

## SUPERNUMERARY BONES OF THE FOOT

astragalus was also an accessory bone, the os trigonum, not in any way dependent upon the sustained trauma.

Recently I was consulted about an X-ray of a slightly injured foot. The physician thought the case especially interesting because it showed a chipping off of a part of the scaphoid and no other

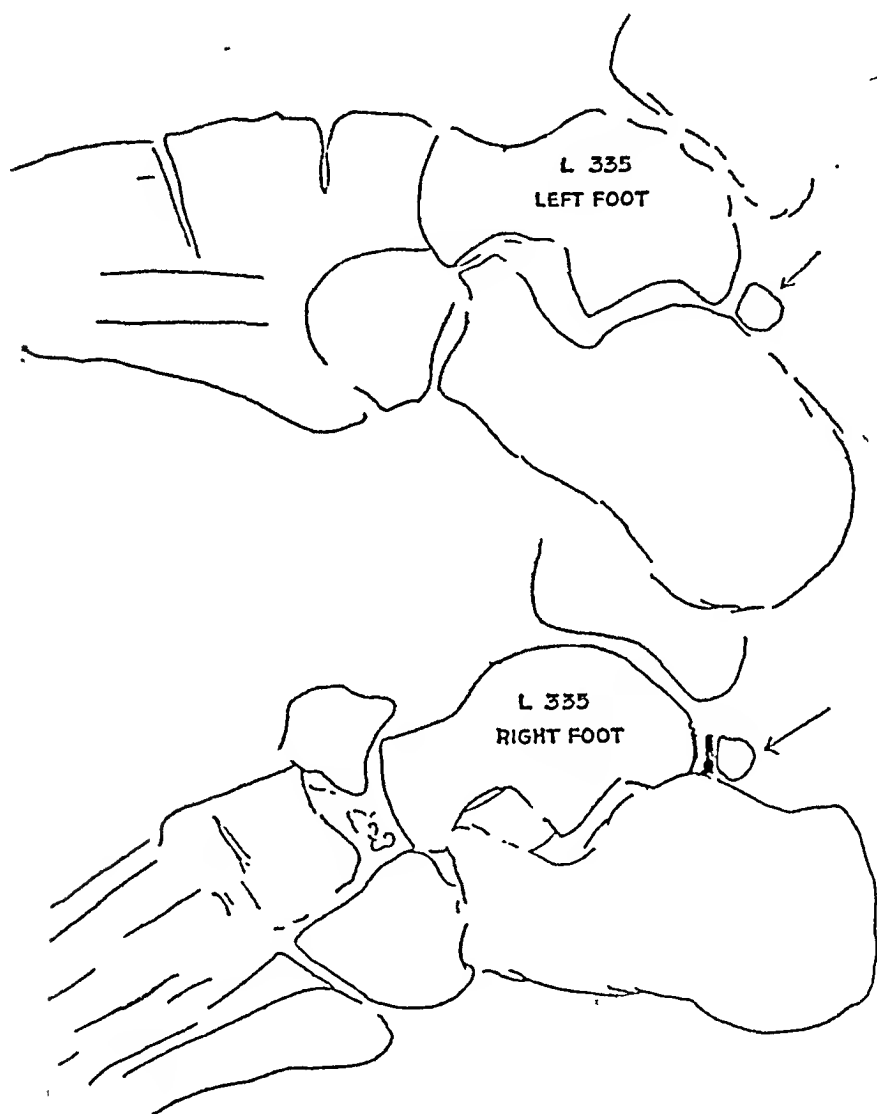


FIG. 3.—L340. Both show trigonum distinct from astragalus. Right foot shows displacement of the navicular, due to injury.

injury. The shadow was perfectly regular in outline and represented the sesamoid in the tendon of the tibialis posticus muscle, called the os tibiale externum.

The irregularities of the dorsal surfaces of the astragalus and scaphoid are interesting because they are sometimes erroneously interpreted as osteo-arthritis.







FIG. 6.—Os tibiale externum bilateral. Exceptionally large, overlapping scaphoid.

*there is clinical evidence attaching importance to them or there are lesions elsewhere in the foot of which these irregularities may be a part.*

*Os Trigonum* (Figs. 1, 2, 3, and 4).—This bone, like all other super-

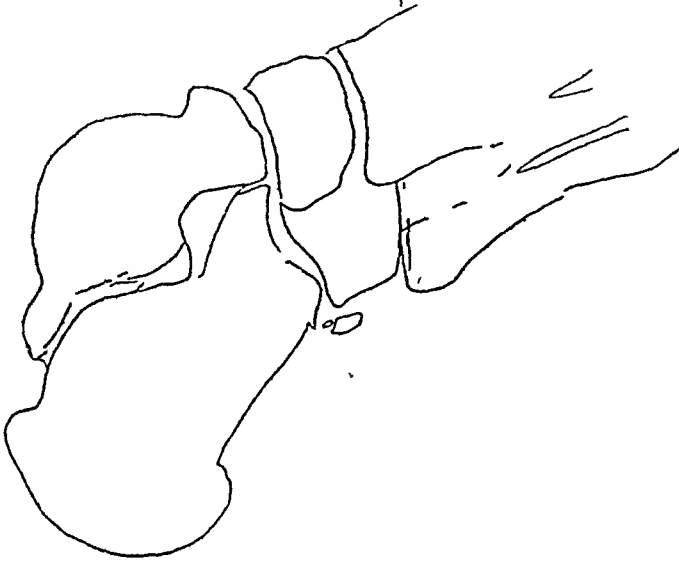


FIG. 9.—K80. Left foot, two "peroneum" bones. Right foot shows only one peroneum.

numerary bones, is characterized by regularity in outline. It may be small or large, may vary in shape from oval to circular or triangular, and may be fused with the astragalus or distinct from it. Of 19 cases,

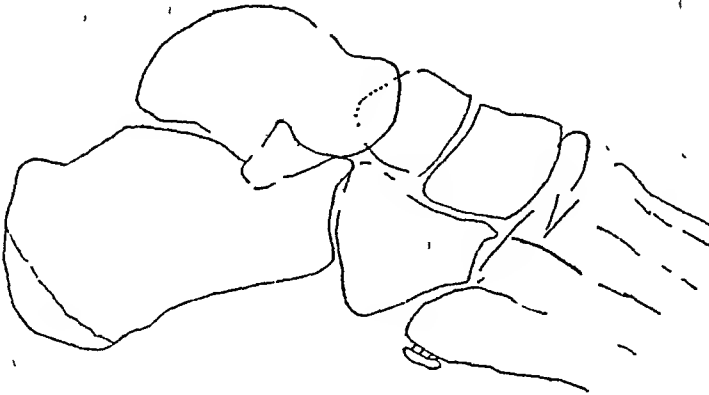


FIG. 10.—L208. Vesalianum.

in 6 it was found in both feet. It may be fused on one side and separated on the other. Its position is constant, being directly behind the astragalus.

## SUPERNUMERARY BONES OF THE FOOT

There were in addition 4 instances of divided sesamoids of the big toe tendon. This does not represent an accurate proportion, because many of the plates did not include the front of the foot. There were several instances of spurs on the posterior and inferior surfaces of the os calcis unassociated with any history of rheumatism, trauma or

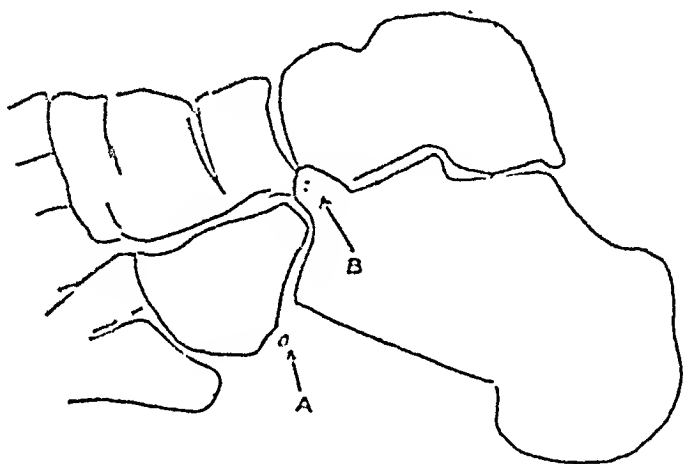


FIG. 7.—L415. Same on both sides. *A*, peroneum; *B*, secondary os calcis.



FIG. 8.—L309. Right foot. Very large peroneum.

gonorrhœa, and hence were simply accidental anatomic variations. There were many variations in the outline of the superior border of the astragalus and the posterior and inferior borders of the os calcis. *Variations in the outline of the tarsal bones may be disregarded unless*

laminous in the second month of the embryo. When this bone is fused with the scaphoid one may infer its presence by the size of the prominence.

*Os Peroneale or Peroneum* (Figs. 7, 8, and 9).—This bone is placed

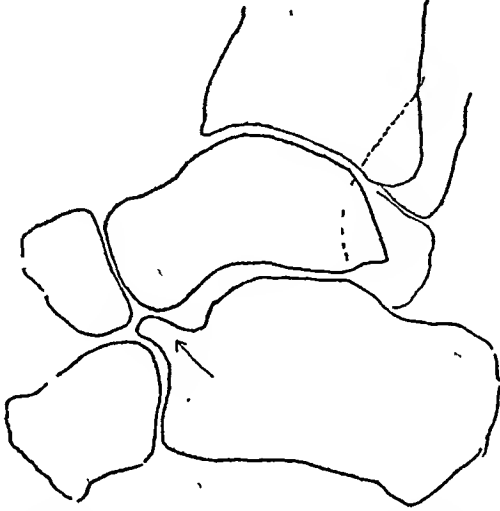


FIG. 13.—K84. Shows process at anterior superior extremity of os calcis very distinctly, representing probably a fused secondary os calcis.

on the outer side of the cuboid. It is a sesamoid in the tendon of the peroneus longus muscle. In the 20 cases in which it was seen it was always very distinct from the cuboid. It appears to vary in size more

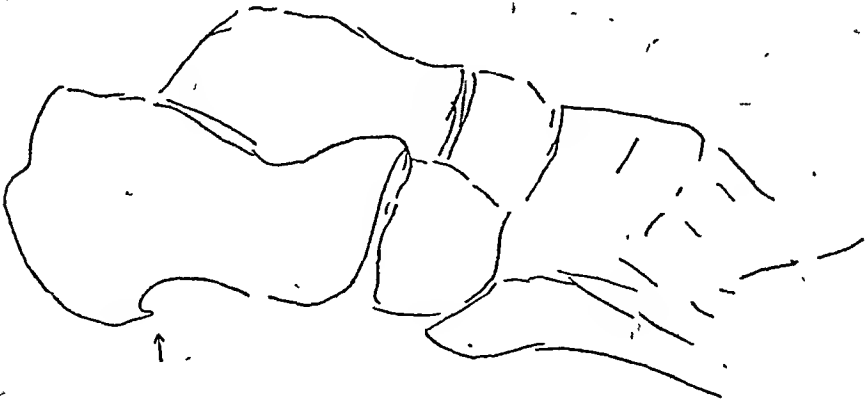


FIG. 14.—L216. Sharp projection of tubercle of os calcis.

than any of the other bones, as is shown in the accompanying illustrations. In 2 instances it was found to be subdivided. It was seen in both feet in 8 of the 20 cases.

*Os Vesalii or Vesalianum* (Figs. 10, 11, and 12).—This bone is

## SUPERNUMERARY BONES OF THE FOOT

*Os Tibiale Externum* (Figs. 5 and 6).—This bone is usually circular or oval in outline and situated on the inner side of and slightly behind the scaphoid. It is important to remember that when this bone is distinct from the scaphoid, its shadow sometimes overlaps that of

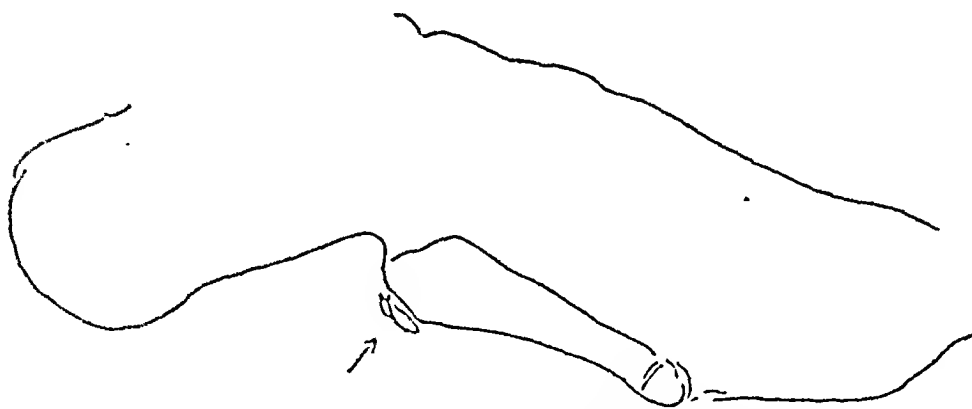


FIG. 11.—K175. Both feet show same finding; bipartite vesalianum.

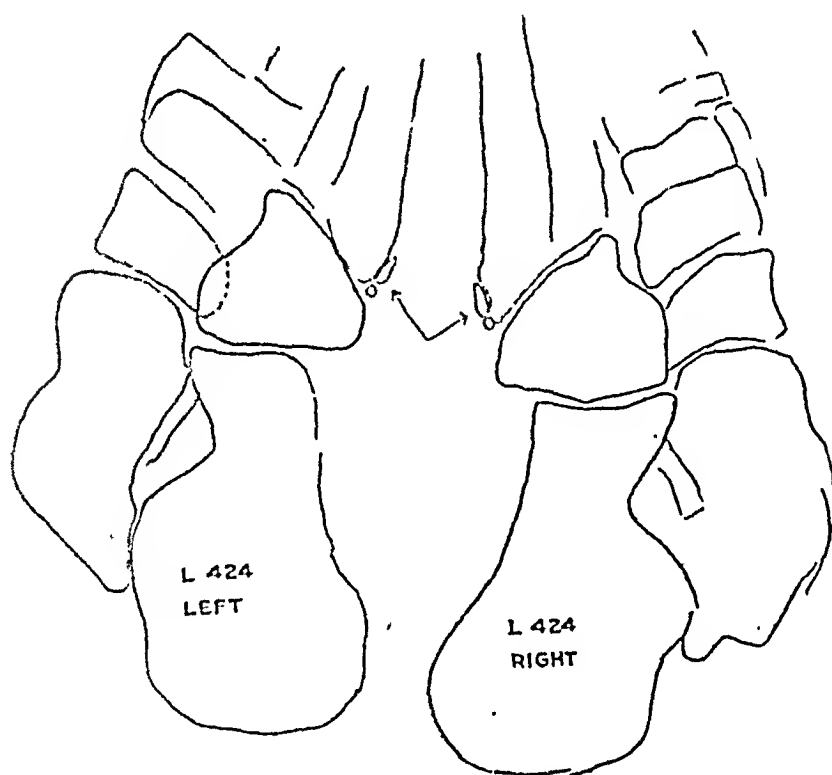


FIG. 12.—L424. Bipartite vesalianum.

the scaphoid. It was found in both feet in 4 of 12 cases. Though it is usually considered as a sesamoid in the tibialis posticus tendon, Dwight believes it to be a true part of the skeleton, since he has found it carti-

bone, but in 7 cases there was an unusually long projection of bone in the interval between the astragalus, scaphoid and cuboid that corresponded with what is described as a secondary os calcis.

*Spurs of the Os Calcis* (Figs. 14, 15 and 16).—Reference to the drawings will show the outline of this bone to be very variable. The



FIG. 17.—L384. Prominence of superior surface of head of astragalus.

inferior surface frequently presents definite spur formation. This also occasionally occurs on the posterior surface. In one case there were two bony spurs on the inferior surface. These must be considered simply as accidental bony projections into the muscle attachments.

*Astragalus* (Figs. 17 and 18).—The upper surface of the astragalus



FIG. 18.—L209. Same on both sides—irregularity in outline of superior surface of astragalus.

often presents sharp projections which may also be present on the scaphoid. Such projections occurring in a plate that is somewhat indistinct may simulate osseous hypertrophies suggesting osteo-arthritis.

*Sesamoids in the Big Toe Tendon* (Fig. 19).—There are usually two sesamoids near the distal extremity of the first metatarsal bones.

## SUPERNUMERARY BONES OF THE FOOT

placed at the proximal extremity of the fifth metatarsal. It was found in 4 cases. In each instance it was distinct and the patient's history excluded the possibility of a fracture. In 2 cases it occurred in both feet and in both instances the bone was subdivided. In one case it was con-

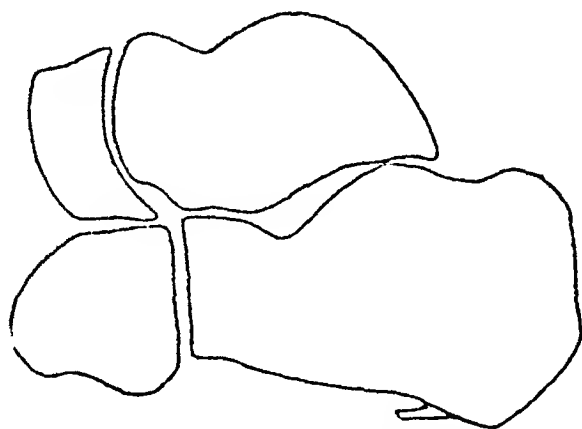


FIG. 15.—L269. Sharp projection of tubercle of os calcis.

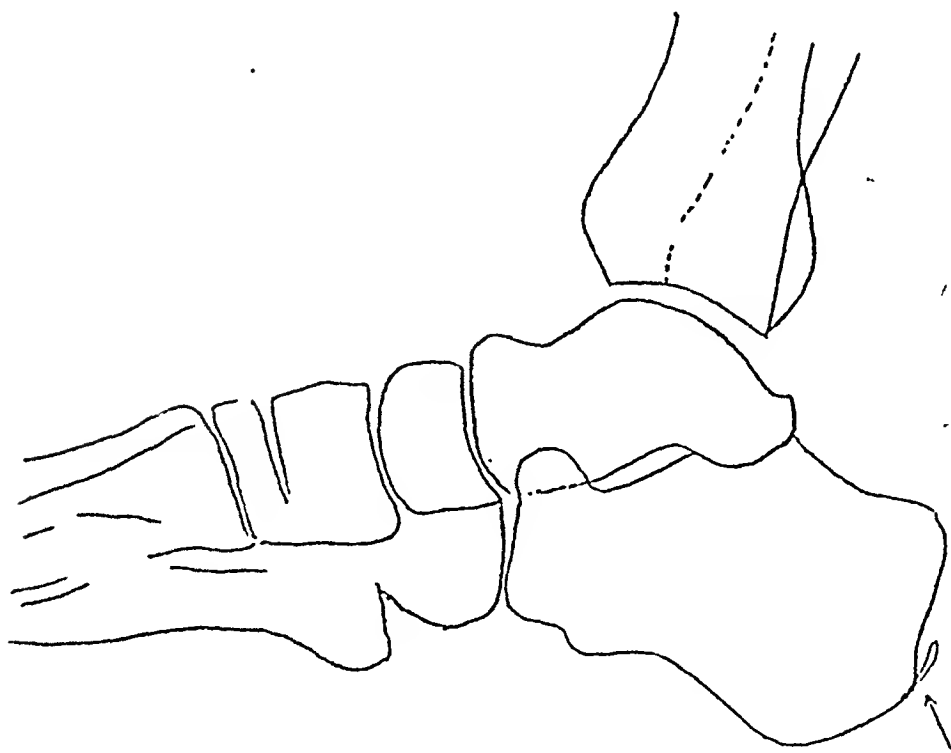


FIG. 16.—Spur on posterior surface of os calcis. Same condition on other foot.

nected with the metatarsal by strands of osseous tissue; in the other cases there was a depression in the metatarsal bone corresponding in size and shape to that of the os vesalii.

*Secondary Os Calcis* (Fig. 13).—This was never seen as a distinct



# TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting, Held January 8, 1917*

The President, DR. CHARLES H. FRAZIER, in the Chair

## MULTIPLE MOVABLE BODIES IN KNEE-JOINT

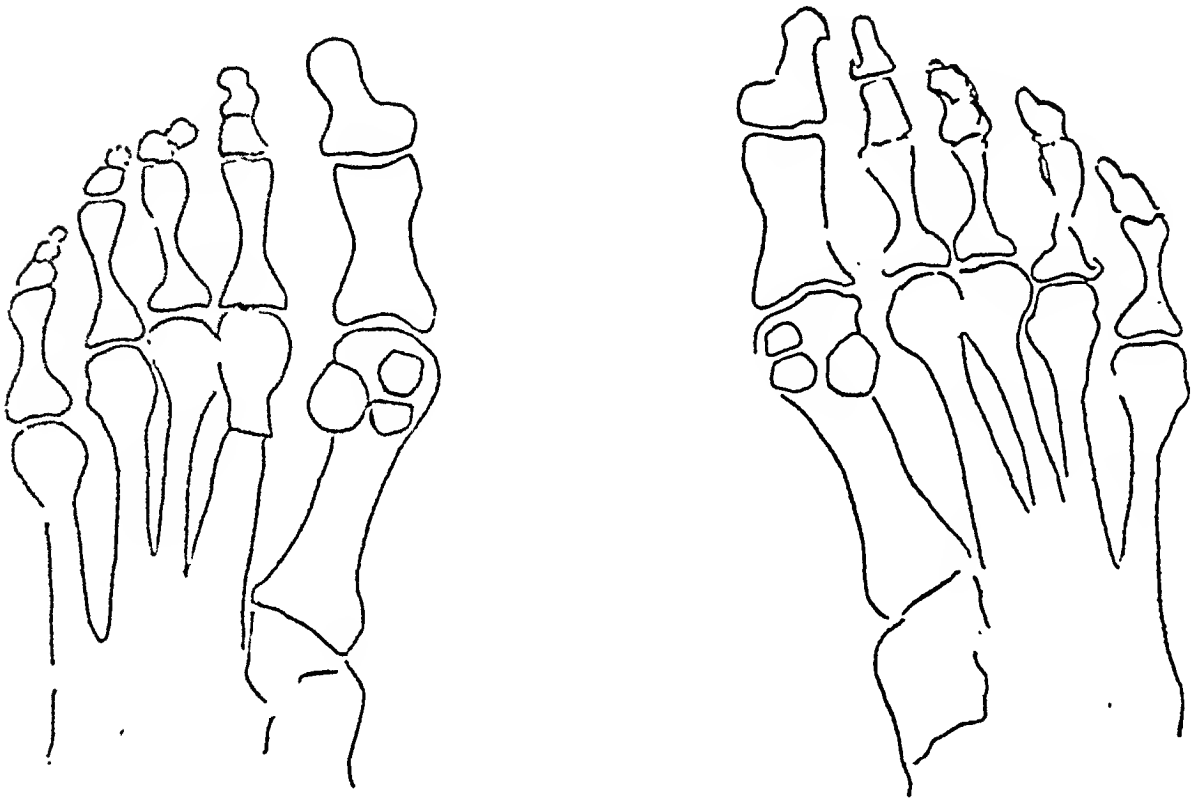
DR. T. TURNER THOMAS reported the following case: Man, fifty-one years old. Health has always been good except for trouble in right knee of about thirty years' duration. At twenty-one years of age had scarlet fever which left him with a severe inflammation of the right knee. This kept him in-bed or on crutches for about eighteen months or two years. At twelve years of age had a severe injury of the soft tissues about the left knee, but he has never had any trouble with this knee since then. The right knee was very stiff after the crutches were given up, but normal motion gradually returned and for many years he experienced no trouble in the use of the limb. About four years ago, this knee suddenly became fixed in flexion, with severe pain and a sense of a giving way of the limb under him. This kind of attack has recurred many times since, sometimes as often as once in every block walked, sometimes not for several days. Frequently, following an attack, the knee swells and then cannot be fully extended. On palpation numerous bodies can be felt moving about in the joint and the femur, tibia and patella are considerably deformed (Fig. 1).

*Operation* (December 15, 1916).—At the Stetson Hospital. An incision was made on each side of the joint, running vertically alongside of the patella and turning backward along the joint line to its posterior limit. It extended through all layers into the joint. This was essentially the Jones incision for the removal of the semilunar cartilages. Twenty foreign bodies were removed. Most of them were completely detached. Two large, irregular ones were attached. Just below the patella, under the synovial membrane, were two small bodies which were cut away. Above the patella, under the synovial membrane, in the roof of the suprapatellar bursa, were two other small bodies, which were seized with forceps and pulled away. Another was attached back of the external condyle and was pulled away with some difficulty. The wound was closed in layers by catgut, a dress-

## SUPERNUMERARY BONES OF THE FOOT

Occasionally one of these is subdivided. The writer has seen only split inner sesamoids. The division is made by a transverse line into anterior and posterior parts. Subdivision of the sesamoids has been seen in both feet in some cases and only on one side in others.

Though I have tabulated the number of times I have actually observed each bone, the frequency of their occurrence is not so essential as the knowledge of their existence.



Left foot  
Right foot  
FIG. 19.—Bilateral split sesamoid. Note fracture of left second metatarsal. Split sesamoid might be mistaken for a fracture. (Ingaborg Anderson.)

### CONCLUSIONS

1. Supernumerary bones are frequently found in the foot. Though they vary considerably in size and shape, they are constant in position and regular in outline.
2. Irregularities in the outlines of the tarsal bones often occur as variations in anatomical conformation.
3. It is especially important to recognize the presence of accessory bones and variations in outline in a foot that is diseased or has been injured.





Fig. 1.—Micrograph of specimen removed from lake.

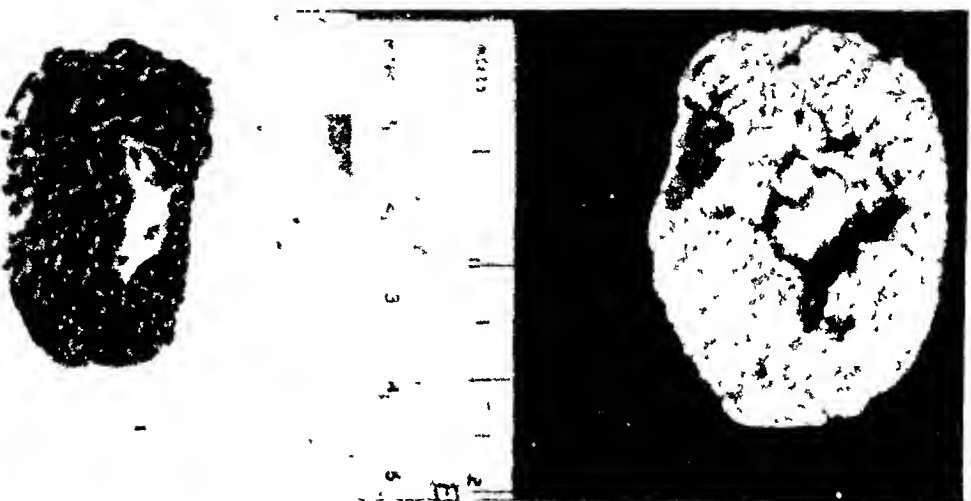


Fig. 2.—Micrograph of specimen removed from lake.

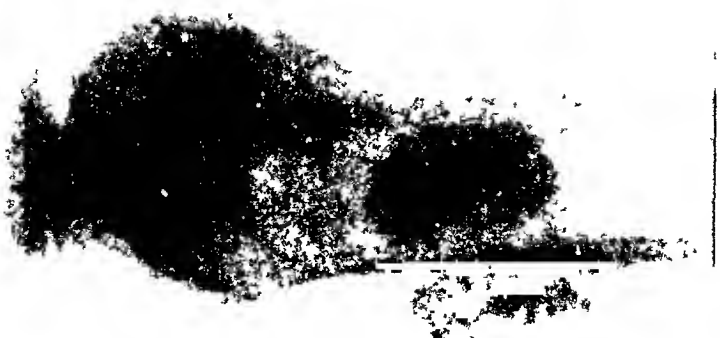


Fig. 3.—Micrograph of specimen removed from lake.

trostomy was done and a No. 16 Fr. flexible bougie was passed,<sup>1</sup> from the stomach through the stricture and brought out through the anterior nares, and allowed to remain in position twenty-four hours. This was replaced by a soft rubber catheter which had a fenestrum a few inches inside the stomach wall, through this liquid nourishment was administered every three or four hours. A shot clamped upon a silk ligature was swallowed and brought out of the gastrostomy wound. By means of this ligature bougies were passed at intervals through the stricture and also a strong silk ligature was passed with which Abbe's operation was done on two occasions. Gradual dilatation was practised with bougies until a No. 30 could be passed. The gastrostomy wound healed promptly and the patient can now swallow solid food. He is now in good condition, weighing thirty-three pounds. On account of the tendency to recontraction of the stricture, bougies should be passed for some time.

#### CYST OF THE TIBIA

DR. JAMES K. YOUNG reported the case of a white girl, of Russian birth, thirteen years old, who came under observation at the Polyclinic Hospital in May 22, 1916, suffering from osteitis fibrosa cysticus, of three years' duration, of the lower end of the tibia (Fig. 4). There was a large mass, 5 cm. in each diameter, occupying the outer malleolus and including the entire lower portion of the tibia, there was also a longitudinal scar over this region from a previous operation performed two years ago by Dr. D. L. Despard, who incised the cyst which was found to contain a soft sanguineous mass which was thoroughly cauterized with carbolic acid and treated with alcohol, and the wound closed. After this some improvement was noticed. The examination had shown that the walls of the cyst were thin; it was sensitive to pressure and had been increasing in size. The condition was differentiated from giant-celled sarcoma, which was the condition it most resembled, by the length of time it had existed, the slow growth, and the X-ray appearance. Three methods of treatment were presented. First, a conservative treatment; second, excision and bone transplantation; third, curettement and bone transplantation.

1. Under the use of a weight sustaining apparatus and alterative treatment with local and X-ray treatments, the X-ray pictures showed a distinct change in character, becoming more dense, the cyst diminished in size and lost its sensitiveness. 2. The second method is not to be recommended, as better results are obtained by curettement. 3.

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<sup>1</sup>Retrograde catheterization easier and more successful than catheterization from above.

## STRICTURE OF THE ŒSOPHAGUS

ing and plaster case applied. Primary healing. Was out of bed in ten days and left the hospital in three weeks, wearing a split case for support and using crutches. As the lateral ligaments of the knee on both sides were completely divided, it is intended to allow them to unite strongly before the case is put aside entirely, which will be done about six weeks after operation.

DR. CHARLES H. FRAZIER reports also a case in which he removed from the knee two unusually large foreign bodies (Fig. 2). The patient was admitted to the University Hospital September 21, 1916, with the following history: That he had sustained an injury to the knee cap thirty years ago, which gave him, however, very little trouble. Last winter he noticed some pain and swelling in the joint, which has continued to the present time, and he was treated for rheumatism. He also had had pain in both elbow- and both wrist-joints. In other respects the history is practically negative. An examination reveals apparent enlargement of the bones entering into the formation of the knee-joint and two movable masses can be detected in the joint on either side of the patella. The presence of these foreign bodies was confirmed by the X-ray plates (Fig. 3). At the operation an incision was made above the patella through the middle of the quadriceps extensor tendon. The joint cavity was opened and the loose foreign bodies found and removed. No others could be felt. The capsule of the joint appeared to be thick and rather œdematous. The margins of the patella presented the appearance rather characteristic of hypertrophied arthritis. The wound was closed with tier sutures and convalescence was uneventful. The diagnosis returned from the Pathological Laboratory was chondroma.

## STRICTURE OF THE ŒSOPHAGUS

DR. HENRY R. WHARTON reported the following case: Robert T., two years of age, was admitted to the Presbyterian Hospital, November 21, 1915, having a few hours before swallowed a solution of concentrated lye. At this time his condition was urgent, temperature 104.2, pulse 150, respiration very rapid. His condition improved in a few days, but he was unable to swallow semisolids, although he could swallow liquids. Numerous attempts were made to pass œsophageal bougies without success. He took food readily, but it accumulated in the œsophagus and was regurgitated. Under ether-anæsthesia attempts were made to pass bougies without success. A bismuth X-ray showed that the stricture was located at the gastric end of the œsophagus. As the patient was rapidly becoming emaciated, in spite of rectal feeding, his weight at this time being twenty-three pounds, on August 19 a gas-





FIG. 4.—Cyst of the lower end of the tibia.



## PHILADELPHIA ACADEMY OF SURGERY

At operation the shell of bone was partly removed, the interior curetted, and the wound closed without drainage. Two years later the patient was perfectly well and he had not been able to trace her at the present time. The tissue removed from the interior of the bone was typical of granulation tissue with a few giant-cells, and at one place the pathologist reports the presence of cartilage, but on looking at the plate now, they are inclined to believe that the cartilage is not present.

DR. A. P. C. ASHHURST said that these bone cysts in children are practically always benign, but in a patient of eighteen to twenty-five years one must be cautious in regarding them as benign. He had operated on four cases of bone cyst—three in children and one in a girl of twenty-one years. In the latter case the tumor recurred after the first operation. When he did an incision of the bone subsequently all the pathologists to whom he submitted specimens reported the tumor to be a much more malignant type than ordinarily seen in these cases; the stroma was sarcomatous, and did not resemble granulation tissue, as is the case in benign growths.

DR. GWILYM G. DAVIS had operated on a case of this character six or eight years ago in a child of four or five years of age with a cyst of the lower end of the ulna. He simply broke away the outer wall and curetted the cavity, in which there was some granulation material, found to be sarcomatous in structure, and depressed the sides. The wound healed nicely and has remained healed ever since.

### ILEOCÆCAL INFANTILE STENOSIS

DR. ASTLEY P. C. ASHHURST reported the following case: Thomas B., aged two years, was admitted to the Episcopal Hospital, November 25, 1915, with symptoms of acute intestinal obstruction. The illness began November 22, with recurrent attacks of abdominal pain; during the attacks the baby gripped his belly with both fists. As he had suffered with similar attacks all during his life, no great alarm was felt. Vomiting set in, however, and on the third day of what was now seen to be the severest attack he ever had suffered, he was sent to the hospital.

*Examination* at 1.30 P.M., soon after admission: The child lies quietly on his back, apparently exhausted. His eyes are hollow, his tongue and skin very dry. He has just vomited some bile. Since admission there have been several attacks of sudden abdominal pain, the child crying out, and clutching at his belly. There is violent peristalsis. There is no rigidity, except during the attacks of pain. Above

## CYST OF THE TIBIA

The third method of treatment consists of curettement and bone transplantation. If the bone cyst increases in size and becomes more sensitive, it is proposed to curette the cavity, crush the walls and transplant the fragment of bone in order to retain the shape of the cavity and prevent deformity.

DR. GINSBURG said that two bone cyst cases have been encountered during the past three years in the Fracture Clinic at the Mt. Sinai Hospital. One occurred in the lower extremity of the radius, and the other in the upper extremity of the humerus. Spontaneous fracture occurred in both cases, and during the process of bone repair both cavities were largely obliterated. The bone cyst in the radius appeared to be multilocular, and before union was complete the entire cavity was still not completely obliterated. Pathological fracture appears to be a certain means of obliterating a bone cyst, and is far superior to any surgical method employed.

We know little about the real underlying pathology of bone cysts, and in our cases X-ray plates of other long bones in the body fail to show the presence of cystic degeneration.

G. P. MÜLLER said that he, in 1904, reported a case of benign bone cyst, and wrote one of the first papers published in this country upon this disease, although a number of cases had been previously reported. Since then many more cases have been reported and several good papers, notably those of Bloodgood, Silver and Landon, have been written. Some eighty cases in all have been reported. Dr. Young states that it is his intention to remove most of the wall of the cyst and to transplant bone to take the place of the defect. The simple crushing of the wall of the cyst is sufficient, and is followed by prompt bone formation. Bloodgood has shown this in all of his reports and there does not seem to be any necessity for extensive bone transplants in these cases. In one case reported by Dr. Landon and operated on by Dr. Müller, the patient had a large cyst of the femur surrounded by a mere shell of bone. Crushing part of the walls of this cyst sufficed to bring about a cure. There was entire regeneration of the bone some months later. In looking over the records of Dr. Frazier's service in the University Hospital, the following case has been found which has never been reported:

Elizabeth H., aged fifteen. The trouble began one year previously as a swelling in the hand, without pain, and without history of injury, and with no other symptoms. Examination revealed a spindle-shaped swelling on the fourth left metacarpal, firm but not of bony hardness, and capable of indentation. An X-ray plate revealed a bone cyst.

## PHILADELPHIA ACADEMY OF SURGERY

mass and the ascending colon (into the anterior longitudinal band, not as shown in the diagram into the median side of the colon). The appendix was not removed, owing to the precarious condition of the patient. The time of the operation was thirty minutes.

Recovery was entirely uneventful. The child was taken home one month later, December 25, 1915; and was seen at first at rather frequent intervals. The child is now in perfect health. No attacks of abdominal pain have occurred since operation.

It was not until after the operation, with its rather disconcerting findings, that it was learned from the parents that the child had been subject since earliest infancy to precisely similar attacks, none of which however had been so severe or had lasted so long as that which finally compelled them to seek hospital treatment.

The question of most interest is whether the tumor caused the intussusception, or whether the intussusception caused the tumor. The former supposition is more reasonable, in view of the fact that repeated but milder attacks had occurred more or less constantly throughout life, and that the tumor had not the least evidence of being due to cedema or swelling. It was as like the tumors seen in infantile pyloric stenosis as one pea is like another.

### STAB WOUND OF THE DEEP EPIGASTRIC ARTERY

DR. PENN G. SKILLERN, JR., reported a case of wound of the deep epigastric artery, and supplemented it with a discussion of the surgery of that vessel, for which see page 450.

### STAB WOUND OF MESENTERIC VEIN

DR. GEORGE P. MÜLLER reported the case of a butcher, age twenty-five years, who, while at work, slipped and fell against a long, sharp meat knife which he was using at the time. It entered the abdomen. He became faint, and had some abdominal pain, and a few hours later was brought to the University Hospital on the service of Dr. Charles F. Frazier.

The history of the injury, general abdominal rigidity, some dulness in the flanks, and a leucocytosis of 17,000 were suggestive of intra-abdominal hemorrhage, possibly also of peritonitis. Operation was immediately performed (July 14, 1916). On opening the abdomen it was found to contain a considerable amount of fluid blood, and investigation revealed three punctures of the mesentery through which blood was oozing, and a nick in the serous coat only of the intestine, just above the mesenteric wounds. The knife had evidently nicked the bowel, and penetrated the mesentery twice, just as a pin is passed

## ILEOCÆCAL INFANTILE STENOSIS

the umbilicus, a transversely placed, sausage shaped tumor is present, which is slightly movable, and not very tender. A diagnosis of intussusception was made, and the child was prepared for operation.

*Operation.*—Under the anæsthetic 3 P.M. (gas-oxygen, preceded by morphin sulphate grain  $\frac{1}{48}$  and atropin sulphate grain  $\frac{1}{400}$  ) no such tumor as above described could be palpated. It was nevertheless determined to proceed with the operation. A right paramedian incision was made downward for three inches from the umbilicus. There was no peritonitis. The lymphatic vessels of the small and large bowels were

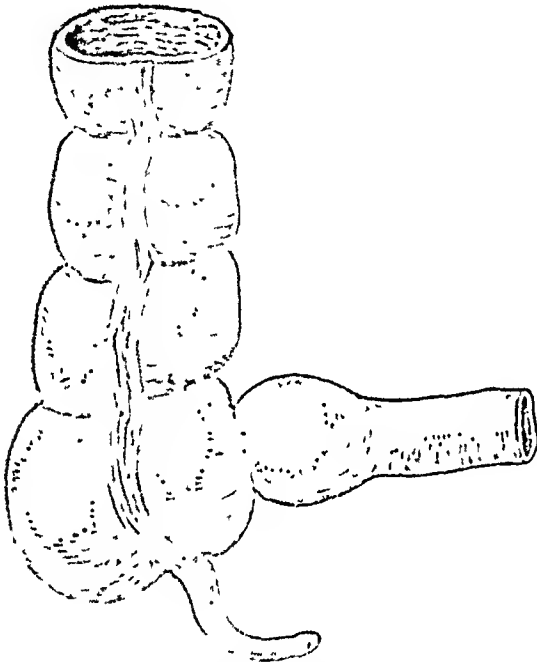


FIG. 5.—Tumor of ileum proximal to ileocecal opening, causing stenosis.

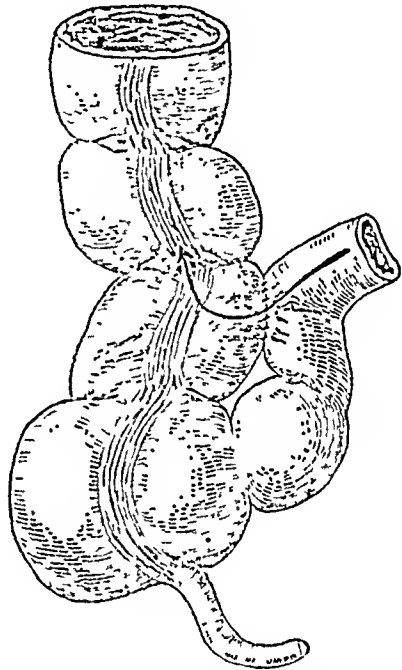


FIG. 6.—Ileocolic anastomosis to short circuit stenosis of ileocecal opening.

distended. The transverse colon was normal. The small bowel was not distended. A movable mass, the size of a guinea-hen's eggs, was felt in the ileocæcal region. The small intestines were then packed off with pads, and the ileocæcal coil was delivered through the incision. No intussusception was now present, but there was a tumor in the ileum just above the ileocæcal valve, about 4 cm. in length, precisely resembling the tumor seen at the pylorus in cases of infantile stenosis. There were several inflamed epiploic appendages on the cæcum and ascending colon, but no enlarged mesenteric lymph-nodes were detected. The wall of the ileum felt thick, and the lumen appeared to be almost obliterated by the tumor which involved the whole circumference equally (Fig. 5). Apparently there had been an intussusception of this mass into the cæcum and ascending colon. A lateral anastomosis (Fig. 6) was made by suture between the ileum just proximal to the

ample drainage was provided the patient subsequently succumbed to the pyelitis. While the findings were negative, there would seem to be no explanation of the dysuria other than the pressure of some such congenital form of obstruction as Dr. Randall has referred to.

DR. H. L. CECIL, of Baltimore, said that the condition of median bar may be divided into two forms: congenital and acquired. The congenital forms date from birth or early childhood and give symptoms of small stream, weak force, straining on urination, etc., with the symptoms of obstruction as manifested by the patient's general condition. The acquired form usually dates back to middle life or early manhood. The symptoms are essentially the same as in the congenital form, except that the patients are seen earlier in the disease and usually do not show such grave general symptoms. The cause of this form is probably anything that may cause a chronic prostatitis or cystitis; namely, gonorrhœa, sexual excess, sexual excitement without gratification, masturbation, etc. However, many of the patients did not give a history of anything that might have caused the condition, so far as we know.

The symptoms produced by median bar may be divided into (1) urinary, (2) painful, and (3) sexual. Among the cases observed in the clinic of Dr. Hugh Young, at the Johns Hopkins Hospital in Baltimore:

(1) *Urinary Symptoms*: 16 had retention; 11 had incomplete urination; 14 had sudden stoppage; 18 had urgency; 47 had hesitancy; 92 had frequency; 35 had small stream; 28 had weak force; 7 had hæmaturia; 11 had pyuria.

(2) The symptoms of pain may be divided into local and referred: *Local pain*: 12 patients had pain at the end of urination; 24 patients had pain during urination; 6 patients had pain before urination; 5 patients had pain constantly in the region of the bladder; 26 patients had pain at the vesical orifice. *Referred pain*: 18 patients had pain throughout the urethra; 24 patients had pain at the end of the penis; 21 patients had pain in the perineum; 11 patients had pain in the rectum; 7 patients had pain in the back.

(3) *Sexual symptoms*: *Desire*: Lost, 6 patients; impaired, 19 patients. *Erections*: Absent, 6 patients; impaired, 11 patients; painful, 1 patient. *Ejaculation*: Absent, 7 patients; precocious, 5 patients; painful, 4 patients. *General symptoms*: 4 patients were uræmic; 7 showed definite septic symptoms.

*Age*: Before 20 years of age, 1 case; 20 to 30, 3 cases; 30 to 40, 8 cases; 40 to 50, 36 cases; 50 to 60, 35 cases; 60 to 70, 30 cases; 70 to 80, 17 cases; 80 to 90, 3 cases.

## MEDIAN BAR FORMATION

through a coat lapel. Between the leaves of the mesentery there was considerable bleeding, and this extended for six or eight inches on either side of the wounds. The punctured areas were caught *en masse* and ligatures applied. The blood clots were removed from the abdomen and the abdomen washed out with salt solution. The patient was discharged nine days after the operation and recovery was uneventful.

DR. GWILYM G. DAVIS said that before exploratory operations were as common as they are now he had a case of stab wound of the deep epigastric artery rather high up, just below the lower edge of the ribs. The wound was enlarged slightly but it was so difficult to control the bleeding that he made an incision about an inch below the wound and placed his index finger in underneath and compressed the deep epigastric artery against the abdominal wall. That controlled the hemorrhage and enabled him with the other hand to enlarge the wound sufficiently to control the bleeding vessel without further difficulty. He did not recommend that technic to-day, but it answered well in that case. In that instance there were no such symptoms as mentioned in the paper. In many of these cases of stab wound, although the abdominal wall is perforated, the intestine may not be seriously damaged.

## MEDIAN BAR FORMATION IN THE URINARY BLADDER

DR. ALEXANDER RANDALL read a paper with the above title, for which see page 471.

DR. CHARLES H. FRAZIER had under observation a case which might be interpreted as illustrating the type of obstruction which Dr. Randall has referred to in his classification as congenital.

The patient was three years of age. His mother said he was always more or less feverish and urinated frequently. What was thought to be incontinence proved later to be retention with overflow. Owing to an existing cystitis the child complained at times of great pain. The urine contained large quantities of pus and the phthalein test showed but 15 per cent. elimination in two hours on one occasion, 25 per cent. on another. There were occasional rises in temperature, and a provisional diagnosis of pyelitis was made as a complication of the vesical obstruction.

An exploratory suprapubic cystotomy was performed. The bladder was found to be distended, extending up to and above the umbilicus. A careful inspection failed to reveal the cause of obstruction, although in the absence of any form of obstruction in the urethra there must have been some congenital lesion at the urinary meatus which interfered so consistently with the evacuation of the bladder. Although

mucous, muscular or periacinous or a combination of these. This inflammatory change may be either acute or chronic, though usually chronic and of long-standing. The most frequent location of this chronic change is just beneath the mucous membrane at the vesical orifice. This chronic inflammatory process causes the formation of connective tissue which is piled up at the vesical orifice and subsequently leads to median bar.

The inflammatory change may, however, be deep-seated instead of superficial, in which case microscopic examination shows the muscle bundles widely separated by connective tissue throughout which there is an active chronic process.

Of about equal frequency as the submucous type is the periacinous. Here the most marked inflammatory process is just beneath the mucous membrane of the glands. Further from the glands there is a great increase in connective tissue. In this way there is a great increase in the tissue of the subcervical or subtrigonal group of glands which leads to median bar.

The acquired form of hypertrophy is identical with hypertrophy of the prostate and needs no comment.

From a pathological point of view the cases that have not been relieved show either an acute inflammatory process or a hypertrophy.

The one objection to the punch operation—that of hemorrhage—has been to a large extent obviated by the use of a cephalin-coated catheter. The cephalin is dissolved in as small amount of ether as possible and this concentrated solution of cephalin is allowed to drop on the rotating catheter; the ether quickly evaporates and leaves a smooth coat of cephalin. The coating extends from the eye for about three inches back. Thus, when the catheter is in place, pure cephalin is brought in direct contact with the cut surface at the vesical orifice. This local hæmostatic, recently described by Dr. Howell, has been used on all the punch cases during the past six months at the Brady Urological Institute, with the result that practically none of these cases bleed.

DR. EDWARD MARTIN said that this discussion is limited to obstruction at the neck of the bladder, the part of the prostate palpable through the rectum bend and the urethral length not being largely increased. It is true that obstruction thus placed and conditioned may be due to a median bar, but not always, since there may be a fibrosis of the internal vesical sphincter producing a ring-like constriction. Although there are no completely convincing microscopic studies of this type clinically, there is a hard annular obstruction which can be

## MEDIAN BAR FORMATION .

The cystoscopic findings were as follows: 114 cases had median bar; 36 cases had lateral enlargement; 18 cases had an anterior lobe; 4 cases had polyp at the vesical orifice; 3 cases had hypertrophied trigone; 19 cases had diverticulum; 42 cases had marked trabeculation; 14 cases had vesical calculus.

*Residual urine:* 3 patients had complete retention; 14 patients had over 200 c.c.; 36 patients had between 50 and 200 c.c.; 74 patients had below 50 c.c.; 6 patients had no residual.

The number of cuts made at the time of operation was judged entirely by cystoscopic findings, three being the usual number and these usually directed posterior, right and left posterior.

Every effort has been made to ascertain the results in these cases by having the patients return for examination and when it was not possible to do this have the patients fill out a circular letter. When patients returned if they had any of the old symptoms, or if on examination residual urine was found, the case was not regarded as cured. Seventy patients were cured; 13 patients were 90 per cent. improved; 16 patients were 75 per cent. improved; 13 patients were 50 per cent. improved; 3 patients were 25 per cent. improved; 13 patients were not improved.

The 13 patients that were not improved were cases in which the principal symptoms were pain, irritation or frequent urination due to contracted or painful bladder, although before operation cystoscopic examination showed a definite median bar. The punch operation was done in these cases in the hope it might relieve the symptoms. These cases may be classified as follows: 3 patients had definite hypertrophy of the prostate; 5 patients had cystitis; 2 patients had pain in posterior urethra; 3 patients had greatly contracted bladder.

A study of these cases shows that the punch operation will do all that it is intended to do, viz.: completely remove obstruction at the vesical neck due to a bar, valve, or circular contraction. It also generally cures the irritation, pain and frequency as well. But in some cases these painful symptoms are due to other lesions in the posterior urethra or bladder, and require appropriate additional measures.

The congenital bars are due, as we have seen them, to hypertrophied muscle of the internal sphincter or a great increase in the connective tissue between these muscle bundles. This type usually shows but little if any inflammatory change. The acquired form may be either inflammatory, which is by far the most frequent, or a definite hypertrophy of the gland tissue.

The inflammatory type shows usually an inflammation, either sub-



no experience with the punch operation. It is doubtless satisfactory in the hands of Randall and Young and in the hands of men who are experts in cystoscopy, and the operation should be confined largely to the practice of those men. The safer method rather than the one proposed by Dr. Randall would be that of suprapubic exposure by which one can actually see the condition and deal with it with less liability of complications.

DR. B. A. THOMAS called attention to a paper in the *Ohio State Medical Journal*, April, 1915, by E. O. Smith of Cincinnati, who discussed the subject of "median bar formation" or obstruction. Smith cited a number of cases and showed excellent pictures of two or three gross specimens similar to some shown by Dr. Randall, in which enlargement of Albarran's glands, causing obstruction, was beautifully shown. Contrary to Dr. Randall's conception, it has been his custom to regard "median bar formation" not as one involving the median lobe of the prostate, a premise which is not generally admitted, but which the essayist this evening states should be considered, including everything obstructive at the vesical neck "with the exception of the lateral lobes." Personally, he did not think that simple hypertrophy of the median lobe of the prostate belongs in the caption of so-called "median bar formation."

He had been accustomed to recognize five types of "median bar formation" or obstruction at the neck of the bladder. They are: (1) glandular; (2) fibrotic inflammatory; (3) fibrotic non-inflammatory; (4) muscular contracture; (5) congenital mucosal fold.

The glandular type of this disease has its origin in Albarran's subcervical or Home's subtrigonal group of glands, but should not include hyperplasia of the median lobe of the prostate. The second and third types are fibrotic in character, and may or may not be associated with inflammatory changes associated with the underlying prostate. The fourth type is that which clinically we are accustomed to consider as a muscular contracture of the vesical neck, possibly the result of neurological or inflammatory affections. This opinion is also held by a number of renowned authorities—Guyon, Marion, Bazy, Frankel-Hochwart, Chetwood and others.

The work of Young with respect to the microscopic study of sections in about 100 cases did not show that the muscular element entered into the condition at all. However, it is possible that by the punch operation enough glandular or fibrotic tissue is not removed to catch the underlying muscle or fibres of the sphincter. The last is the congenital obstruction. This he had never seen but he had no doubt it may occur, simply as a fold of the mucosa at the vesical orifice.

## MEDIAN BAR FORMATION

felt by the finger, which obstructs the passing instrument and which can be relieved only by section or wide dilatation or both. Obstruction in practically all cases is largely influenced in its degree by spasm and congestion, as this obstruction in the ring cases is more inveterate and lethal than that due to the ordinary hypertrophied prostate which we take out.

The operative attack, of course, is at the site of the obstruction. This we have carried out by fulguration, by the punch—which has not been entirely satisfactory; but most successfully and safely by a suprapubic opening, inspection, palpation and the meeting of the indications, either by removal of adenomatous growth or section of an obstructive fibrous bar always followed by very wide dilatation of the internal sphincter or by multiple sections of a localizing ring.

Dr. Randall spoke of the renal degeneration and atrophy which always accompany obstruction low down and which are factors in hastening the fatal ending, whatever the disease from which the patient suffers. The difficulty in treating many of these cases is that they have never been catheterized, and are not infected. There is no known method, no human skill by which can surely be avoided infecting these cases on the first catheterization. The infection when it occurs travels up into the kidney by the lymphatics with a resulting pyelitis and pyelonephritis to which these congested and damaged kidneys are peculiarly susceptible and from which some of these patients promptly perish. For that reason the cases which have survived their first infection may be better risks than those who have never been infected. And it therefore follows that in the case of a fairly comfortable and able-bodied person there is a perfectly justifiable hesitation in instrumentation of any kind, even gentle catheterization, since this in spite of every precaution may be followed by an ascending and fatal infection. When the obstructive symptoms become urgent this risk must of course be taken.

DR. JOHN B. DEEVER said that he had operated on these cases in years gone by, exposing by the suprapubic method and removing the enlarged portion with the rongeur forceps. He had used the Sir Henry Thompson instrument. He had found that the ordinary rongeur forceps, such as is used in other operations, answers very well. He agreed with Dr. Randall that in these fibrotic prostates or median bar enlargements, one cannot do a total enucleation with the same degree of ease and safety as one can the above mentioned operation. We know how much more grave from the operative standpoint removal of a small hard prostate is in comparison to a large prostate. He had had

## PHILADELPHIA ACADEMY OF SURGERY

The operative procedures directed to the relief of median bar formation or obstruction resolve themselves into the following: (1) suprapubic cystotomy, followed by removal of obstruction at orifice, either with ordinary cranial rongeur or with Young's punch. (2) Young's median bar excisor or punch operated per urethram, as designed. (3) Chetwood's galvanocautery, through perineal incision. (4) Destruction by high frequency spark (so-called fulguration).

He agreed with Dr. Deaver regarding the method of operation in the majority of cases, that is as described under (1). In those cases where a fibrotic bar exists at the vesical orifice, Young's punch will be of service when the rongeur fails. Used in conjunction with cystotomy, the danger from hemorrhage and infection incident to the punch operation is reduced to a minimum. Employed only per urethram as designed, he believed the danger following the punch operation is greater than that from the open operation, either by the suprapubic or perineal route. He had used Young's punch in a number of cases and in one case was unfortunate enough to have the patient die of embolism within a week after having been considered out of danger. Of course, one cannot say that embolism might not have occurred had the operation been of another kind. However, a number of urologists have reported serious hemorrhages, even deaths, following this operation.

Chetwood's galvanocautery incision of the vesical neck through the perineum has permanently supplanted the Bottini-Freudenberg procedure per urethram, but it too enjoys a rather restricted field of utility, and should be reserved for only the most advanced and intractable forms of contracture of the vesical orifice.

Fulguration or the high frequency spark may be applicable to a limited number of cases, but should not substitute more rational and better procedures. As a rule, even in the glandular type of obstruction, this method is likely to prove unsatisfactory because of the necessarily prolonged and painful course of treatment.

DR. RANDALL, in closing, said that he feared he had been rather vague in describing the median bar, and he confessed he was still a little vague in his own mind regarding exactly what it means. He started out in this work thinking that he had a very definite picture of what he would find. As time has gone on he had had to modify and modify that picture, for as the specimens increased he had found more borderline conditions, and specimens in which, with the naked eye only, it was impossible to say the origin of the tissue causing the obstruction. The work has continually pointed to the need of microscopic study in

## MEDIAN BAR FORMATION

The German urologists in recent years have regarded atrophy of the prostate as a cause of median bar formation or contracture of the neck of the bladder. In a recent article Dr. Randall also seemed to attribute atrophy of the prostate as a cause of this condition. He could not see by any thought of histopathology how atrophy of the prostate can possibly cause such a state of affairs at the vesical orifice. He did not believe it is the cause, although not infrequently atrophy of the prostate is present. Why cannot prostatic atrophy be associated with or the counterpart of the same condition that causes contracture of the neck of the bladder? The importance of "median bar formation" will be realized when it is remembered that approximately 10 per cent. of patients complaining of symptoms of prostatism are cases of *prostatism sans prostate*, and do not belong to the well recognized group of simple prostatic hypertrophy, in which the treatment is essentially and frequently radically different.

In the proper treatment of the conditions, two thoughts should be borne in mind primarily by the surgeon: First, whether or not syphilis may be present. The second is that to which Dr. Randall alluded, spermatoecystitis, as a gonorrhoeal sequel. It has been shown by Belfield, of Chicago, that, as a result of seminal vesiculitis with inflammation and infiltration of the base and neck of the bladder, symptoms may arise such as median bar formation causes. Within the past eighteen months he had seen three cases with considerable amounts of residual urine, one with fifteen ounces, with no other possible cause than a definite chronic periseminal vesiculitis. The cysto-urethroscope, although not always all sufficient diagnostically in all cases, is invaluable in differential diagnosis.

He agreed with Dr. Randall that as to treatment each case is a study unto itself. Rectal palpation, to determine if possible the state of the seminal vesicles and lateral prostatic lobes, and in conjunction with the use of the cysto-urethroscope to learn the thickness of tissue intervening between the rectum and vesical neck, is important. Just as in prostatectomy for simple hypertrophy either suprapubically, or perineally, so here with "median bar formation" or obstruction at the vesical neck it is paramount to determine, first, the operability of the patient by any method, and, second, operative procedure best fitted for the particular patient. For the first he recommended more strongly than ever, the index elimination of indigocarmin, than which there is no better, or more reliable test for the determination of kidney function. Reliance mainly upon this and discrimination as to route has obviated a prostatectomy death now for two years and eight months and a mortality rate of barely 3 per cent.

## BOOK REVIEWS

THE CATARRHAL AND SUPPURATIVE DISEASES OF THE ACCESSORY SINUSES OF THE NOSE. By ROSS HALL SKILLERN, M. D. Second Edition, Thoroughly Revised, Philadelphia and London; J. B. Lippincott Company.

This newly revised edition is issued just three years after the first appearance of the work. It was and still is the first work published in English entirely devoted to diseases of the accessory sinuses. The first edition was fully reviewed in these pages. This review therefore will deal chiefly with the new or revised parts of the work. The additions of new matter in the present edition are sufficiently important to be listed in detail from the preface. They are: The treatment of sinus disease in children; the use of the nasopharyngoscope in the diagnosis of obscure conditions in the posterior ethmoid and sphenoid regions; the diagnostic needle puncture of the maxillary sinus more fully explained, with possible dangers and how to avoid them; Canfield's operation in the maxillary sinus is compared with the preturbinal method, with instructions for and illustrations of both the immediate and ultimate effects of operations on the sinuses; a compilation of the American mortalities following the Killian operation on the frontal sinus; complete revision of the chapter on the sphenoid sinus, with description and illustrations of Halle's new operation; a chapter on combined empyema or multiple sinusitis. The entire work has undergone a systematic revision. Certain statements which seemed obscure have been rearranged and amplified with special reference to rendering them more direct and simple. We note that the former index has been elaborated though this in the opinion of the writer might be carried still further.

The first edition of Skillern's book was welcomed by American rhinologists as an important contribution. It incorporated a great part of the very important advances in the treatment of the nasal accessory cavities which had been made during the preceding decade. The book afforded for the first time an opportunity to compare the various operations of different schools set forth side by side for each group of structures.

The new edition brings the work again up to date. The reviewer believes that the additional pages and illustrations incorporate the most important of the many new facts established and new operations devised within the period elapsing since the first edition appeared.

WILLIAM C. BRAISLIN.

## MEDIAN BAR FORMATION

order to distinguish the true underlying pathology, and this phase of the subject was started some months ago and is being carried on as fast as the material is obtained.

He had continued to use the term "median bar" because it was the one employed by the man who first recognized and described the condition, but he used it in a very broad sense, covering with it all obstructions situated at the posterior vesical orifice unassociated with hypertrophy of the lateral lobes.

He felt that he had touched rock-bottom in but two places. He had presented four types of obstruction. He had found two types of obstruction at the posterior vesical orifice, the first is fibrous, the second glandular. Each allows of a second subdivision; the fibrous into bars that point (*a*) urethraward, and those that have an (*b*) upward-vesicalward-tendency of growth; while the glandular obstructions (call them bars if one will) may either be the (*c*) hypertrophic nodule or lobe from the subcervical glands, or the (*d*) thick, rounded bar from the glandular hyperplasia in the posterior prostatic commissure.

Dr. Martin's remarks in regard to the muscular ring contracture are pertinent. One sees them clinically but what they are from the gross pathological standpoint he was not ready to say.

Dr. Thomas had brought out a fair criticism as to why he included the glandular hypertrophies at all. He had done so because, first, they form a definite type of median obstruction, second, because clinically in certain cases it is impossible to say whether the obstruction is of one variety or the other, and, third, because there are borderline cases in which even with the bladder and prostate in one's hand, one cannot determine the character of the obstructing tissue. It was because of such embarrassments that the microscopic study became an essential.

It had been a great pleasure to hear both Dr. Deaver and Dr. Martin sanction the death knell of suprapubic prostatectomy in the cases of so-called "small fibrous prostates." They are not hypertrophies and unquestionably should not be treated as such. They *are* the bar cases, the cases of *prostatisme sans prostate*: the obstruction is definite but in actuality small, and other surgical procedures than prostatectomy can secure complete relief of symptoms.

## BOOK REVIEWS

lowing, among other opinions with which the chapter devoted to this subject is concluded:

"Carcinoma may accompany or follow abnormal involution in about one case out of ten. No one has seen the transmutation of abnormal involution into cancer. Exaggerated fear of the occurrence of carcinoma after abnormal involution has led to unnecessary mutilation of patients by the removal of many breasts that show no important disease. Instead of amputation without examination, the breast should be investigated by plastic resection. If normal it should be let alone; if slightly and locally diseased, the diseased areas should be excised. In cases of badly diseased breasts, simple amputation is indicated. In cases of carcinoma, radical amputation should be performed."

The chapter devoted to the subject of carcinoma contains fully illustrated details of the various methods of technic which have been devised to carry out present accepted ideas of the diffusion of the disease, and the requirements for its radical extirpation. Dr. Deaver, in devising the details of his own method, has been influenced by the teachings of Handley with reference to the extension of the disease along the deep fascial planes.

The book as a whole is a most important addition to the literature of diseases of the breast, and will always remain of value as a full presentation of present knowledge and practice in such diseases.

LEWIS S. PILCHER.

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### To Contributors and Subscribers:

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**ANNALS of SURGERY**

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## BOOK REVIEWS

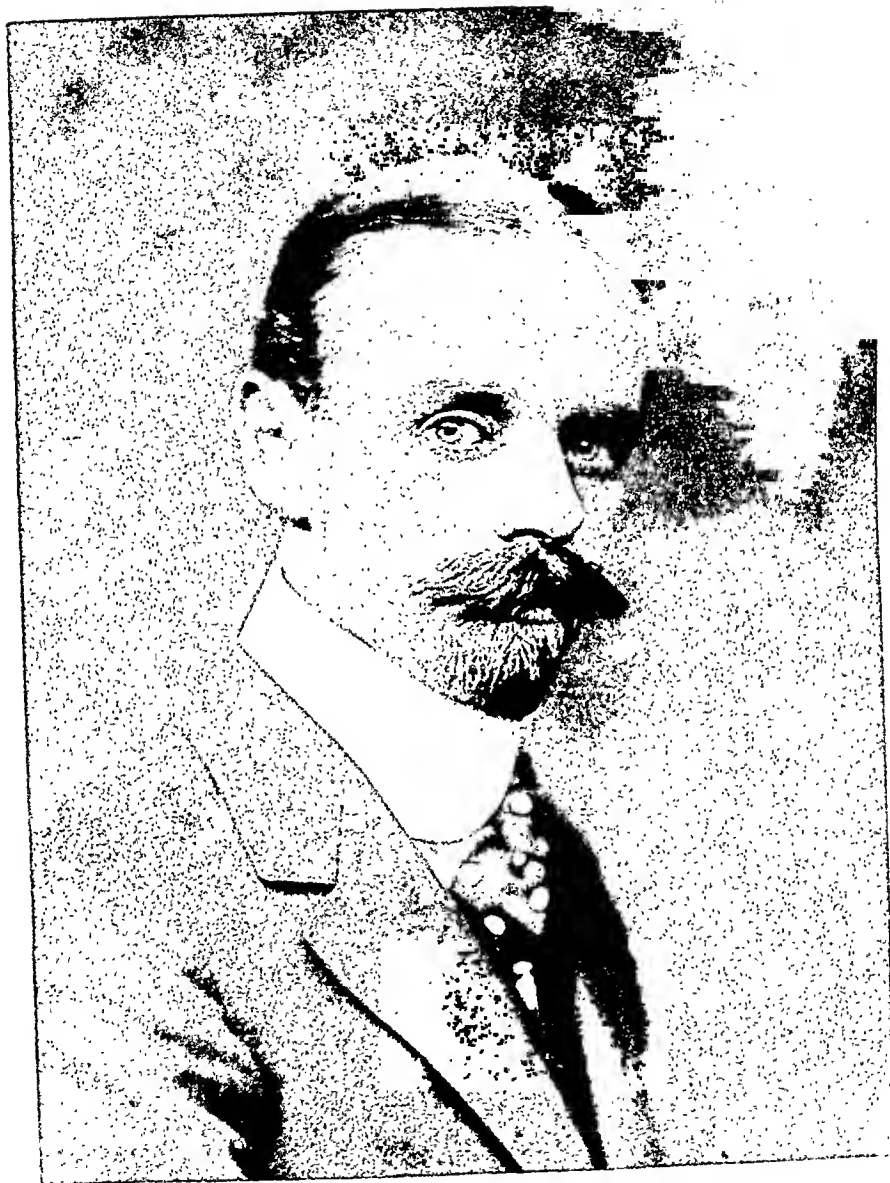
THE BREAST, ITS ANOMALIES, ITS DISEASES AND THEIR TREATMENT.  
By JOHN B. DEEVER and JOSEPH MCFARLAND assisted by J. LEON HERMAN. Large octavo, pages 724. Philadelphia: P. Blakiston's Son and Company, 1917.

This is an encyclopædic work which by reason of the collaboration of masters in clinical surgery, pathology and anatomy has been made to embody knowledge and teaching which ranges from the domain of embryology to the latest suggestions of technic in the removal of neoplasms. A full bibliography is given of each topic discussed. One of the most interesting chapters is that devoted to the anomalies of the breast. The reader will find gathered together in this chapter an amount of singular information as to such anomalies which cannot be found elsewhere, and which is full of curious interest. Special mention should also be made of the pages devoted to the subject of tuberculosis of the breast which contain tables giving details of all cases which have been discovered in literature up to the present time, being forty-eight primary cases and twenty-nine secondary cases, with a very full bibliography of the subject.

The subject of cysts of the breast receives very full discussion. No question has been more mooted among surgeons during recent years than the relations of cystic degeneration (abnormal involution) of the breast and the development of carcinoma. The following quotation may be accepted as a very fair statement of present knowledge on the subject, "It is sometimes urged that both the conditions, carcinoma and abnormal involution, are most frequent at the same period of life, and that therefore they are probably connected with one another. We cannot see the necessity for supposing that two conditions that happen to coexist must be connected with one another in the relation of cause and effect. At a certain age the breast is subject to involution which sometimes becomes abnormal and peculiar. At the same age cancer develops in the breast irrespective of any cause or condition known, but the involutional changes are apt to be numerous and diffused, the cancer quite as apt to be localized. Of course both may be reversed; the involutional disturbance may be localized and the cancer diffused. In the present state of knowledge the questions cannot be answered. We cannot be certain of the relation of the one morbid process to the other. The case is not proven, but the matter is of the utmost importance in its surgical application, for it is upon the theory that abnormal involution is the precancerous stage of cancer that many surgeons are now advising and treating their patients."

The practical conclusions of the authors are expressed in the fol-





James M. Piller



his ingenuity in suggesting so many improvements in the technic of urological operations elicited my highest praise and admiration.

His book on cystoscopy is a most conscientious and splendid effort to make this method of diagnosis an open instead of a sealed book to the rank and file of the profession. His restless ambition was evident to all who came in contact with him, especially his efforts to keep pace with the many and rapid advances of our profession.

As a token of respect and of admiration, keenly alive to the loss of a dear friend and esteemed fellow-worker, his colleagues have chosen this method of publishing a series of contributions to serve as a memorial for one who was destined to be a leader in the profession, and the publishers of the ANNALS OF SURGERY have willingly consented that the present, May, issue of that journal should be devoted to these articles.

BY ABR. M. WOLBARST

It is a great privilege to say a word in commemoration of Paul M. Pilcher. It was a still greater privilege to have known him. I appreciate both privileges, and am better for having had them.

Much may be said of Paul Pilcher as a surgeon; still more, perhaps, as a skilled and progressive urologist. We who knew him, who worked with him, and are still struggling over the same problems as he did, fully realize what a splendid name he made for himself among his colleagues throughout the profession—a name that shall shine among the pioneers of urology.

But to me Paul Pilcher was always more than a good surgeon or a fine urologist. I know other good surgeons, fine urologists. But Pilcher was more than either of these. He was a man of rare personality; vigorous, but never aggressive; strong, but never domineering; modest, yet certain of himself. Even when he opposed you, he did it as you would like to have it done; you respected his opposition. When he was near, one always felt a sense of good will and good fellowship. He carried an atmosphere of good feeling and kindness about him. He was a man in every fibre of his being—a man's man, a man whom men could admire, and did admire, not only for what he did but for what he was. In a word, Paul Pilcher made friends and kept them by force of that great and rare attainment—he was a gentleman. What better can be said of any man?

*Brevis a naturâ nobis vita data est; at memoria bene reditæ vitæ sempiterna.*

# ANNALS *of* SURGERY

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## A TRIBUTE TO THE MEMORY OF PAUL M. PILCHER

BY DANIEL N. EISENDRATH, M.D.

There is a reaper, whose name is death,  
And, with his sickle keen,  
He reaps the bearded grain at a breath,  
And the flowers that grow between.

ON January the fourth of the present year, the surgical profession of America lost, through death from pneumonia, one of the most promising of its younger members—Dr. Paul M. Pilcher.

Although only forty years of age when he died, his many valuable contributions to surgical and, especially, to urological literature had already served to attract the attention of the entire profession. His genial personality and innate modesty had won for him a rapidly widening circle of friends and admirers.

An untiring, conscientious worker, constantly alive to the necessity of improving our methods of diagnosis and operative technic, he lived to see many of his ideas adopted by the fellow-workers in the special field of urology.

After receiving his academic degree at the University of Michigan and graduating in medicine at the College of Physicians and Surgeons of New York, he spent two years as interne at the Seney Hospital, Brooklyn. He continued his work in the European Clinics of Nitze, von Frisch and other urologists and laid the foundation for his work in this field.

In 1910 he relinquished all other hospital work in order to devote his entire time to the development of the Pilcher Private Hospital, in which he was associated with his father and brother. During a visit to this institution in the spring of 1916, the writer was very much impressed with the organization of this rapidly growing institution and the coöperation of the father and the two sons in utilizing the most advanced methods in the diagnosis and treatment of all varieties of surgical cases. The enthusiasm of Paul Pilcher was contagious, and

## PAUL M. PILCHER

energy and an infinite capacity for work for the purpose of developing that branch of our profession and more particularly that department of surgery which this Society represents.

Born in Brooklyn on April 11, 1876, his preliminary education was received at the Polytechnic Institute of that city and later at the University of Michigan, from which latter institution he graduated in 1898 with the degree of Bachelor of Arts. His medical education was obtained in this city and he received his M.D. from the College of Physicians and Surgeons in 1900. In the same year Columbia University conferred upon him the degree of Master of Arts. Following his graduation he spent the next two years on the resident staff of the Seney Hospital where his father, Doctor L. S. Pilcher, was at that time senior surgeon. Having completed his hospital course he supplemented his post-graduate study by a year in Europe working under such masters as Koenig, Orth, Nitze, Von Nisch, and others. His time was devoted entirely to the study of surgical pathology and modern urology. At that time urology was passing through a transitional period. Wonderful strides were being made in the development of more accurate measures of diagnosis and treatment. Doctor Pilcher availed himself of all these exceptional opportunities and here laid the foundation of his work which he so nobly carried forward upon his return to Brooklyn.

From the beginning his efforts were limited to surgery, and his merits and attainments soon won for him appointments on the surgical staffs of the Seney, German, St. John's, and the Jewish Hospitals. His duties at these institutions were discharged with credit, and already young Pilcher was marked as one of the coming men of Brooklyn. Early in his career, however, he resigned from these honored positions that he might devote his entire time and energies to the development of the Pilcher Private Hospital which had recently been started by his father and himself. Here he concentrated his efforts upon the surgical diseases of the kidney, bladder, and ureter. This comparatively small hospital became at once a model for completeness. No appliance that might in any way facilitate the diagnosis and treatment of urinary pathology was missing, and as new developments appeared they were added. Every patient, rich and poor alike, was examined and treated with infinite care and painstaking attention to detail. We of Brooklyn were proud of Doctor Pilcher and the work he was doing in his clinic. It reflected credit upon the profession in our borough.

The news of such work could not be long confined to local boundaries, and the Pilcher Clinic soon attained a national and international reputation. His contributions to urological literature were numerous

## TRIBUTE FROM THE AMERICAN UROLOGICAL SOCIETY

### IN MEMORIAM: DR. PAUL M. PILCHER

THE sudden and untimely death of Dr. Paul M. Pilcher was a great loss to the American Urological Association. He had long been an active participant in the scientific programs of the annual meetings, always presenting something of practical value to the members. His brilliant scientific work and valuable deductions will always rank prominently among those of his contemporaries. His affable manner, his genial nature and his charming personality endeared him to all who knew him.

Therefore, *be it resolved*, that The American Urological Association in annual session in Chicago the fourth day of April, nineteen hundred seventeen, hereby formally recognizes its irreparable loss in the death of Dr. Paul M. Pilcher, and extends its most sincere sympathy to the bereaved family.

*Committee*, E. O. SMITH,  
CARL LEWIS WHEELER,  
HOMER G. HAMER.

### MEMORIAL TRIBUTE TO PAUL MONROE PILCHER, A.M., M.D.\*

ON January fourth of this year, Paul Monroe Pilcher died at the age of forty, and with his death this Society sustained the loss of one of its most active and enthusiastic members.

"Life is not measured by the time we live," but to few, indeed, is given the privilege to live so well and accomplish so much in the brief space of time allotted to our late friend and fellow worker. If we, his friends, believing with a profound faith in divine omniscience that all things are for the best, should wonder why such a man should be taken from our midst in the very zenith of his activity and power and influence, we may, perhaps, find some comfort in the thought that that inscrutable Providence which controls our destinies and shapes our ends recognized in the life of Paul Pilcher a life that was already rounded out and complete.

It seems almost superfluous to pronounce a eulogy upon Doctor Pilcher before this body. His life and work were familiar to all of us. Inheriting as he did a talent for surgery, he supplemented those qualities with which Nature had so bountifully endowed him, with a tireless

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\*Read at the meeting of the New York Urological Society, April 11, 1917.

# KIDNEY WITH DOUBLE PELVIS AND DOUBLE URETER: NEPHROLITHIASIS: PYONEPHROSIS: NEPHRECTOMY

BY LEWIS STEPHEN PILCHER, M.D.

OF BROOKLYN, NEW YORK

To the case which is the subject of the following report especial interest attaches, both on account of the anatomical abnormality of which it was the subject, and, more especially, for the reason that it was the last case operated upon by Dr. Paul M. Pilcher before the development of the pneumonia which caused his death. Indeed, at the time of undertaking this operation he was already manifesting the depression premonitory of this disease, and it was only by summoning all his reserved force that he was able to carry it through, and he went from the operating room to his bed. He had, however, promised to operate for the relief of this patient upon the day set, and the patient, on account of his sufferings, was impatient and insistent that it be not deferred. Influenced, therefore, by his professional ardor and by his desire to comply with the promise that he had made to this man, he proceeded with his work. In another aspect this case further illustrates the spirit peculiar to surgeons as a class, inasmuch as for his work in the care of this patient he was not to receive any money reward. It was a charity patient.

The man was forty-one years of age. For four years he had been suffering from intermittent attacks of pain in the right side. For six months previous to admission there had been blood in the urine every day; previous to that time it had been perfectly clear. He had no pain in the bladder. Had to empty his bladder during the day every three hours, and during the night once or twice. When blood was not present in the urine there was a creamy sediment.

Upon *cystoscopic examination*, the bladder contained a normal amount of fluid; no cystitis present; the left ureter opening was normal in appearance and function; catheter entered the left ureter without any obstruction and advanced without trouble. The urine dropped from the catheter in the left ureter in a normal manner. The right ureter opening was swollen and surrounded by small flakes of pus; the catheter entered without disturbance, but caused pain after going up about 10 centimetres. The urine

and valuable. One has but to mention his work on renal tuberculosis, renal varix, and prostatic hypertrophy, all well known to members of the Society, to illustrate the character of his contributions. He found time in the midst of his many duties to edit the *Long Island Medical Journal*, from 1907 to 1911. In 1911 he published his work, "Practical Cystoscopy," which will stand for many years as a monument to his life and ability. More recently he edited a translation of the clinical lectures of Professor Rovsing of Denmark. In addition to being secretary of this body at the time of his death, Doctor Pilcher was a member of the executive committee of our parent Society. He was Chairman of the Section in Surgery of the New York State Medical Society, and only a few months ago was elected to membership in that most exclusive of all surgical bodies in this country, the American Surgical Association. He took an active part in the deliberations of all these societies, he was eloquent in debate, and his contributions were looked upon as authoritative.

Such, briefly, was the life and work of Paul Pilcher—"Fame comes only when deserved, and then is as inevitable as destiny, for it is destiny."

It is perhaps fitting and proper that a Brooklyn member of the Society should voice these final sentiments of appreciation and respect for our late fellow member, for those of us, his neighbors, who knew him intimately came to know that, preëminent as were his professional attainments, his qualities as a man and friend were equally commendable and noteworthy.

I regret that an abler pen than mine could not have more adequately expressed our appreciation of the character of one of our most distinguished members. He was honored by his profession, he was revered by his patients, he was loved by his friends. This is perhaps small consolation to those who were near and dear to him, but it should serve in a measure to assuage their grief, for such a reward can only come to a noble life, nobly spent.

NATHANIEL P. RATHBUN.



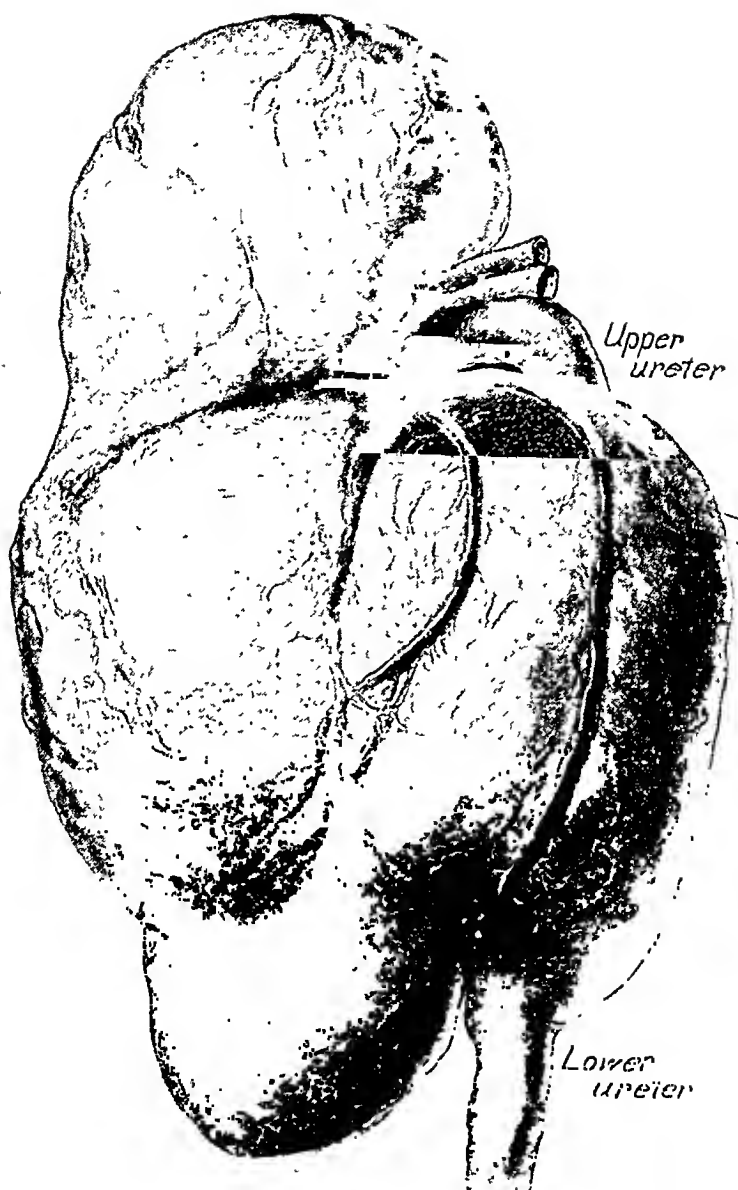


FIG. 2.—Double kidney with pelvis and ureter for each portion, each portion the subject of pyo-nephrosis. Large calculus in lower sac. External appearance at time of removal.

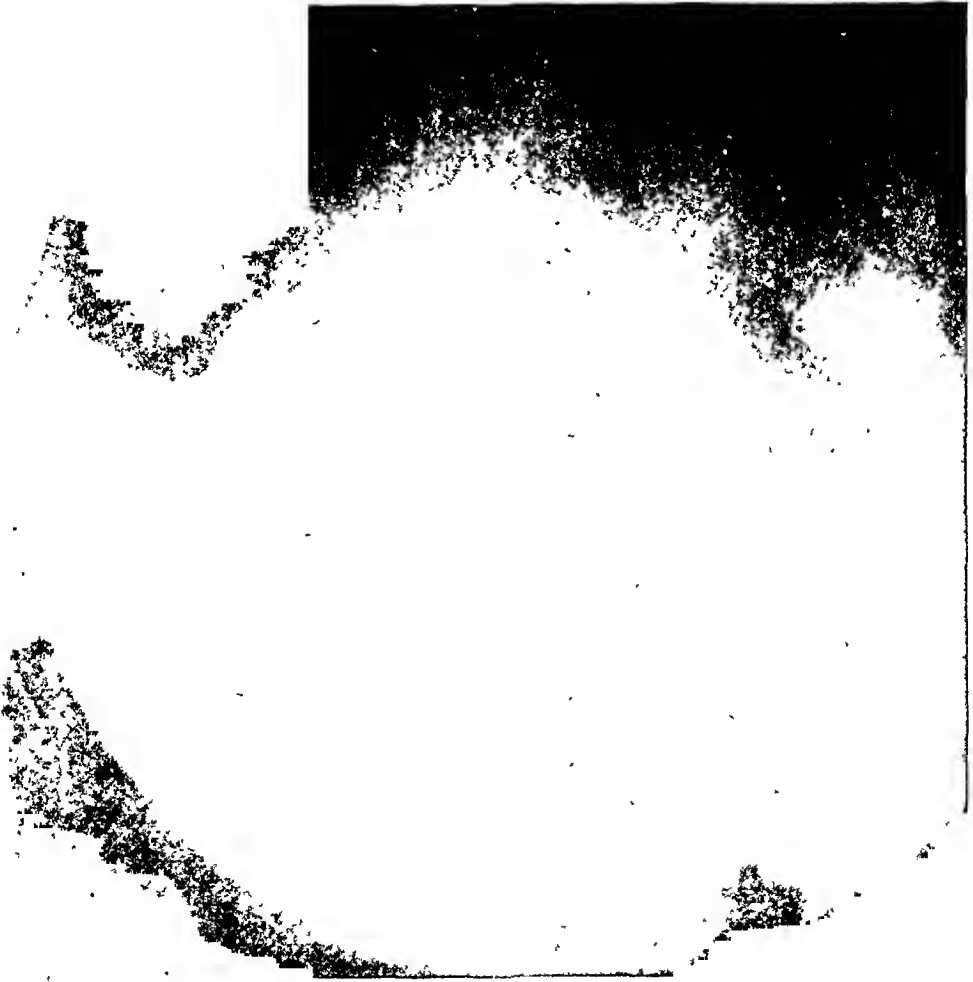


FIG. 1.—Double kidney with pelvis and ureter for each portion, each portion the subject of pyonephrosis. Large calculus in lower sac. Skiagraph before operation. See Figs. 2 and 3. Note the shadow cast by the normal kidney tissue at the upper pole. Note the shadow of the calculus in the lower pole.



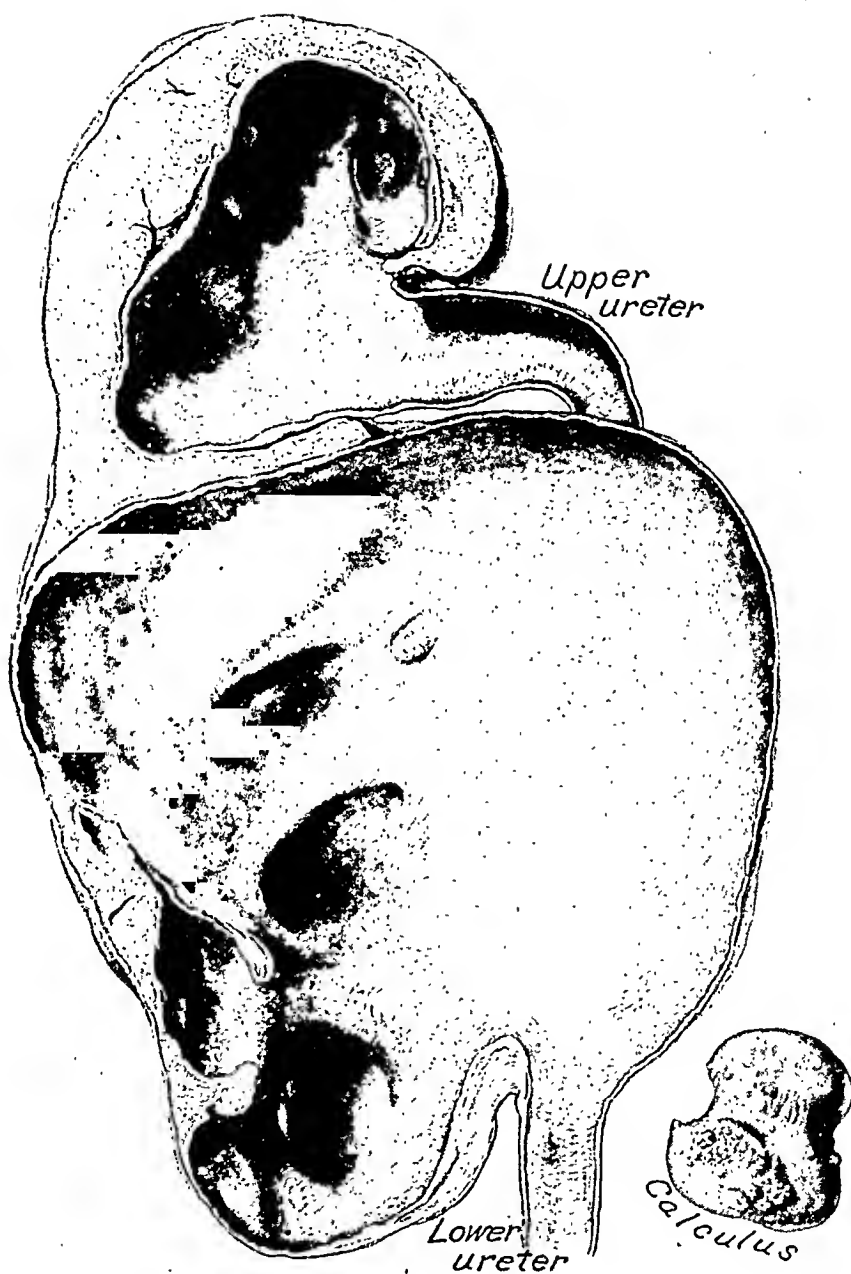


FIG. 3.—Double kidney with pelvis and ureter for each portion, each portion the subject of pyonephrosis. Large calculus in lower sac. Sagittal section.

portion of the cavity below the diaphragm, and a second one in the lower angle of the wound along the lower ureter. After the wound had been entirely closed down to the remaining ureter, the ureter was ligated and divided by cautery, permitting the kidney to be removed without the wound having been soiled at any time by the foul contents of its cavity. The stump of ureter was fastened into the lower angle of the wound by a point of suture.

The patient bore the operation well and reacted promptly. The whole of the vast wound cavity closed by primary union. The cauterized end of the ureter was thrown off as a slough in due time, leaving a granulating surface. A slight separating of the adjacent wound edges also healed by granulation.

Section of the kidney after removal showed there to be two large sacs present (Fig. 3), entirely independent of each other, the larger sac being the lower one, and each having its own ureter. In the lower and larger sac there was a large uric acid calculus. There was very little kidney secreting tissue left in the walls of this sac. The upper half of the kidney contained a sac of similar character, as is shown well in the accompanying cut; but a much larger amount of sound kidney tissue remained in its walls. Its sac communicated with a second ureter, as had already been noted in the course of the operation. It contained no calculus.

In the course of the operative dissection the further course of the two ureters was not followed so as to demonstrate their relations. The upper one was included in the vascular pedicle that was ligated and divided. The lower one was secured in the lower angle of the wound as described. Only one right ureteral opening in the bladder was seen at the time of the cystoscopic examination. The history shows that attempts to pass a catheter into the right ureter met with obstruction after passing upwards about 10 centimetres (four inches). The natural inference is that the point of obstruction was caused by the branching of the ureter at this point. The literature of double ureters sustains the possibilities of such an arrangement.

#### NOTE BY DANIEL W. EISENDRATH, M.D.

In a recent article upon the double kidney, Young and Davis<sup>1</sup> report a case in which the upper half of a double kidney was removed for a hydronephrosis with a large calculus. In addition to this case

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<sup>1</sup> Journal of Urology, 1917, i, 17.

## KIDNEY WITH DOUBLE PELVIS AND DOUBLE URETER

from this catheter dropped rapidly and continuously, showing fluid accumulated in a dilatation of the pelvis (pyohydronephrosis).

Urinalysis	Right Kidney	Left Kidney
Specific gravity .....	1.002	1.012
Urea .....	0.19 per cent.	1.35 per cent.
Albumin .....	+	0
Pus .....	+	0
Round cells .....	+	+
Casts .....	0	0
Calcium oxalate .....	+	0
Phthalein test, amount passed		
in 30 min. ....	0	7 per cent.
Quantity urine in 30 min. ....	3 c.c.	14 c.c.

The X-ray picture (Fig. 1) showed a large stone in the pelvis of the right kidney. In the right kidney region there were irregular areas of density the exact nature of which could not be known. The lack of function after the injection of phthalein with the urinary specific gravity of 1.002, with the large amount of pus, with the urea only 0.19 per cent., and the fact that the left kidney was secreting the normal amount of urine indicated that the right kidney was largely destroyed. Its removal with its contained calculus was therefore advised.

*Operation: Nephrectomy.*—December 27, 1916. Under ether anæsthesia the right kidney was exposed by the usual lumbar incision. It was greatly enlarged, the enlargement being due to a distention of the pelvis of the kidney, including the first portion of the ureter and the lower portion of the kidney. There was evidently a pyonephrosis and a hydro-ureter. Over the greatly dilated pelvis of the kidney large vessels could be seen coursing (see Fig. 2). These were divided and stripped back toward the pedicle at the base. By dividing these vessels the mobility of the kidney was greatly increased, and it was possible to bring it more fully out into the wound. At this time a second ureter, also dilated, was discovered going to the upper pole of the kidney, entirely separate from the first ureter (Figs. 2 and 3). This second ureter was in its normal relations to the vessels entering the hilum of the kidney, as shown in the figure (Fig. 2). The lower ureter which opened into the greater sac which occupied the lower half of the kidney had no vascular relations of importance. The vessels of the pedicle were divided between double ligatures and the kidney was left still attached to the lower ureter, and hung out of the lower angle of the wound. Then the wound cavity was obliterated by a series of buried chromic sutures, with a cigarette drain in place leading up to the deepest

## THE PROBLEM OF PROSTATIC OBSTRUCTION

By JOHN H. CUNNINGHAM, JR.

OF BOSTON

ASIDE from personal feelings at the loss of our friend, Dr. Paul M. Pilcher, the profession and the community are deprived of one whose service has been of singular merit. There is much that he has left in our memory, and when asked to contribute to this memorial number of the ANNALS OF SURGERY, one quite naturally chooses to consider the prostatic problem, about which one can recall many pleasant and profitable discussions with him, and with which subject his name will always be associated. The subject matter which follows contains much upon which we have held the same conviction and other features upon which we have argued at length without reaching agreement.

Prostatic obstruction occupies a peculiar place in surgery, inasmuch as the condition is the most common malady of advanced years requiring surgical intervention. Prostatic patients, therefore, represent a group of individuals past the prime of life in whom degenerative changes have taken place in all tissues to some degree, with the possibility of serious impairment of the functions of important organs as a frequent accompaniment to the more prominent features of derangement in the urinary system. The most common and dangerous are respiratory and cardiorenal. The renal changes, often with infection, resulting in serious impairment of function are by far the most important factors influencing the mortality in prostatic operations, yet accompanying impairment of all bodily functions is not without its influence.

The *pre-operative study and preparation of the patient* for radical treatment and the importance of post-operative care are phases of the subject which have been clearly expressed by Dr. Pilcher. His charts, which he has frequently shown, recording the different phases of renal adjustment, dependent upon bladder drainage, prior to removal of the obstructing gland, have done much to establish the value of pre-operative adjustment of the kidneys before undertaking prostatectomy. These charts show what I have proved to be true; that following the establishment of drainage of the bladder harboring a residual urine, either by bladder drainage *à demeure* or by a suprapubic cystotomy, there is a stage of renal depression; expressed by a drop in the

## KIDNEY WITH DOUBLE PELVIS AND DOUBLE URETER

and one reported by Young,<sup>2</sup> in 1903, they were able to collect twenty-four instances in which this form of anomalous kidney was operated upon. Dr. Pilcher's case and two reported by Eisendrath<sup>3</sup> and Israel<sup>4</sup> make a total of thirty published operations on double kidneys.

The article of Drs. Young and Davis is so complete that it will be freely quoted. All of the cases operated upon showed complete duplication of the renal pelvis and grades of ureteral duplication varying from a bifurcation close to the kidney to a complete supernumerary ureter with a separate vesical orifice. All but two cases were operated upon because of a pathological process in the anomalous kidney, and in all but three the remaining segment was normal at the time of operation. In 19 of 24 cases the pathological condition was located in the upper segment.

In two instances the operation was pyelotomy, in twenty a nephrectomy was done, and in all but one the operation was complete nephrectomy. Sixteen of the double kidneys were half normal and would have afforded an opportunity for partial nephrectomy with preservation of a normal portion according to Young and Davis. Such a conservative procedure can only be carried out, however, when there is a more or less demarcation between the parenchyma of the two halves and if the vessels of the two halves can be separated.

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<sup>2</sup> Monatsb. f. Urol., 1903, 8, 591.

<sup>3</sup> Surgical Clinics of Chicago, April, 1917, 1.

<sup>4</sup> Nierenchirurgie, Berlin, 1901.



of the individual patient two important factors are established: the general condition of the individual and the character of the obstruction to the outflow of urine from the bladder. As a consequence of this knowledge there will be a non-operative and an operative class.

*The Non-operative Class.*—Although relatively small, this class includes (1) those individuals whose general impairment is such that they would not stand the tax of removing the gland, and in whom the character of the obstruction is such that no simpler procedure for relief of the obstruction would be of benefit, and in whom the passage of a catheter is possible—under these circumstances catheter life is preferable to a permanent suprapubic sinus; (2) individuals with carcinoma of the gland without associated benign hypertrophy, in whom regular catheterization is still possible. Prostatic carcinoma rarely has the malignant features of carcinoma elsewhere, and I have had many patients, considered inoperable, go for several years with comparative comfort before it became necessary to establish a permanent suprapubic sinus, while others died of intercurrent diseases. These patients may, moreover, be subjected to whatever benefit radium has to offer; (3) individuals whose general condition is satisfactory, but who have symptoms of prostatism, dependent upon the retention of prostatic secretions and secondary congestion. This class, often having a considerable residual urine with little or no true hypertrophy, need not be subjected to prostatectomy. Emptying of the gland of retained secretions, by massage, at stated intervals, with care in regard to bowel dejections, keeping the urine bland and abstinence from ungratified sexual excitement will result in almost or entire emptying of the bladder; and, while requiring occasional local treatment, the indications are far better met than by operation.

*The Operative Class.*—A clear understanding of the patient's general condition and the type of the prostatic obstruction will have much influence in the choice of the best operative procedure to be employed.

*Operation: Not Radical.*—If the patient's condition is below the standard required for a radical removal of the gland, some less severe method of relief of the bladder retention must be considered. If the obstruction is chiefly intra-urethral and benign in character, the galvano-cautery operation of Bottini, done under local anæsthesia, may offer much in giving a freer outlet by destroying a portion of the obstructing gland. While this operation has fallen more or less into disuse, because of the improvement in the manner of preparation, whereby more patients may be safely subjected to more radical operations on that account, its usefulness is all that it was in the past,

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24-hour amount of urine, the blood urea and phthalein output with a gradual rise in the specific gravity of the urine. This stage of depression is also evident in the general condition of the patient. It is the danger period, through which the patient must pass, and it explains most of the deaths occurring within the first four or five days when prostatectomy has been performed without previously producing renal adjustment by the less severe methods of accomplishment—through constant urethral drainage, secured by an indwelling catheter, or suprapubic cystotomy. Even when employing these methods to secure renal readjustment, I have occasionally had deaths occur unexpectedly. Following the few days of depression dependent upon bladder drainage, as evidenced by the clinical picture and chemical tests, there is a gradual improvement in all respects, which remains more or less constant, but naturally varies with different patients according to the degree of impairment of other bodily tissue as well as the renal tissue.

When this state of individual equilibrium is established, and not before, in cases with a large retention, the patient is in condition to undergo investigation to learn the character of the obstruction and whatever changes may be present in the bladder.

The character of the prostatic obstruction varies greatly; it may be malignant, or, if benign, it may be an intra-urethral or intravesical obstruction, a simple prostatic bar, or contracture of the vesical neck, or the gland instead of being of the large hypertrophied type may be small and fibrous. Cystoscopy is an important aid in not only furnishing information in regard to these points, but it makes possible the determination as to whether or not calculi or diverticuli are present, and much may be learned in regard to the condition of the bladder musculature and mucosa; which features are important to know prior to operation. Cystoscopy is not always possible on account of the obstruction and for other reasons. It is well in these cases to have all the knowledge that the Röntgen rays may furnish in regard to calculi and a cysto- or cysto-uretopyelogram may furnish valuable evidence of the condition of the bladder, ureters and kidneys. It is this pre-operative study, both local and general, and the employment of pre-operative measures to improve the reserve power of the individual patient that is the most important advance which has been made in prostatic surgery during recent years.

*Choice of Treatment.*—It is the information obtained by the employment of these pre-operative features that has led me to the conclusion that there is no one operation applicable to all cases. From the study

and is the means to the end of estimating the recuperative power of the individual; if a catheter can be passed to the bladder through the urethra and secured there, nothing more in the way of drainage can be desired in most instances; and this form of bladder drainage has all the advantage and none of the disadvantages of a suprapubic cystotomy established for drainage. Constant drainage having been established, either *per urethra* or suprapubically, the patient is, to all intent and purpose, relieved of his suffering and can recover lost sleep, in which most are in need, fluids may be forced and the bladder irrigated. Phthalein tests and urinalysis can be repeated every few days; the 24-hour amount of urine recorded, and a knowledge of the renal improvement thus obtained. Upon the recuperative power, as evidenced by the general condition and local examination, will depend the ability of the individual to stand the strain of operation.

*Suprapubic prostatectomy*, either by the one- or two-stage technic, carries a higher mortality than the perineal operation, either by the dissecting or median urethra enucleation methods. The actual advantage of the suprapubic over the perineal route is that a relatively more satisfactory result may be expected.

The whole subject of suprapubic and perineal operations may be summarized, I believe, in the fact that suprapubic prostatectomy carries a relatively higher mortality with a better average functional result. This well-established fact should lead to subjecting only the best risks to the suprapubic operation. Those not coming up to the standard required for suprapubic prostatectomy may often be subjected, with safety, to the perineal operation.

In the *perineal operation* there is also a choice, for the dissecting operations are attended with a slightly higher mortality than the simple intra-urethral enucleation of the gland, yet here, also, a better functional result may be expected, because, as performed by those expert, the compressor urethræ muscle is left intact. The median perineal intra-urethral enucleation of the gland is the simplest method of prostatectomy and is attended with the lowest mortality. It has always carried the chances of a relatively poorer functional result; yet there is no operation for removal of the gland that has been performed so badly by most that have employed it. This simple and rapid enucleation method, performed solely by the sense of touch, requires an accurate appreciation of the structures encountered, for while the external sphincter is divided, the vesical sphincter may be left intact, and, moreover, with a certain knowledge, the divided external sphincter may be united following the removal of the gland; a feature generally disre-

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when it was quite generally employed by those skilled in cystoscopy and the manipulation of urethral instruments, and still offers great relief to the properly selected cases which will not stand the more radical procedure of prostatectomy.

Prostatics, in whom the obstruction is due to a bar at the vesical neck, or sclerosis of the vesical sphincter, whether or not the general condition would permit of a prostatectomy, had best be subjected to the so-called "punch operation," a procedure carried out under local anæsthesia with a special instrument which cuts away the obstructing portion of the gland.

Patients, with a benign or a malignant gland, who are unfit to stand a radical operation and who do not possess the type of gland suitable for the Bottini or "punch operation" and for whom regular catheterization cannot be carried out, either because of the obstructive nature of the gland or because of their mentality, financial or social status, may have to submit to the establishment of a permanent suprapubic drainage. Fortunately this class is small, yet the procedure gives much comfort to the remaining existence of the unfortunate individual. By the employment of a device to keep the patient dry, and with bladder irrigations that the most unskilled can carry out, and occasional removal and cleaning of the drainage tube, these patients are relieved of a most distressing condition.

*Radical Operations.*—Here, also, no one operation is suitable for all cases. Circumstances associated with the individual case should have much influence on the choice of operation. At the first meeting with the patient, acute retention may be present and it may be impossible to pass a catheter into the bladder through the urethra to relieve the retention, whereby it will be necessary to do an immediate suprapubic drainage, in which event, the gland had best be removed suprapubically when the adjustment of the kidneys and the patient's general condition will permit. If the passage of a catheter is possible in such patients, it should be fastened in, and constant bladder drainage secured until the desired adjustment has taken place and the type of obstruction learned.

The discussion as to whether a large adenomatous gland shall be removed by the suprapubic or perineal route will depend upon a clear understanding of how much of a tax the individual patient may be subjected to with safety; yet if the obstructing gland is of the small fibrous variety it should be attacked through the perineal route without question.

*Bladder drainage* is the important feature of pre-operative treatment

done. Without associated benign obstruction, patients with carcinomatous glands should properly fall into the non-operative group.

*Post-operative Care.*—The pre-operative preparation, and observance of details in every way to minimize the tax imposed on the individual, prior, during, and after the operation, has an important bearing on post-operative complications and the final result. The value of personal attention on the part of the experienced surgeon and specially trained nurse cannot be over-estimated; for attention to details and the early recognition and treatment of complications are essential to success in prostatic surgery. It is for this reason, chiefly, that prostatic operations differ from most surgical procedures, and, if the best results are to be attained, the patient had better be sent to the surgeon than to have the surgeon go to the patient, who has been mentally but not physically prepared for operation by his physician, who may expect the operation to be performed immediately and to attend to the after-care himself.

The *complications* may be divided into two classes—local and general. The local disturbances are hemorrhage, wound infection, phlebitis, epididymitis, pyelonephritis and cystitis. The general complications are shock, cardiac embarrassment, apoplexy, embolus, intestinal stasis, hypostatic congestion, with or without pneumonia, and acute renal suppression.

*Local Complications.*—*Hemorrhage:* Hæmostasis at the time of operations is important. The amount of bleeding will vary with the particular operation employed and will depend much upon the skill of the operator in his ability to appreciate that he carries out the enucleation entirely within the capsule of the gland. The line of cleavage between the gland and its capsule varies within wide limits; and while some glands may be enucleated with ease without disturbing surrounding or overlying tissues, others are removed with more difficulty and result in opening vascular areas in the capsule, and tearing of the mucosa at the vesical neck, which may result in enough bleeding to play an important part in the recovery, if left unrecognized. It is important to gain a decisive knowledge as to whether or not the bleeding after removing the gland is sufficient to require attention, and there is probably no technical point upon which operators are more at variance. Some insist that it is rare that hemorrhage from the prostate area requires any attention, and argue that a moderate amount of bleeding will take care of itself, and that, as most prostatics have a high blood-pressure, slight bleeding is beneficial rather than otherwise. There are others, however, who insist that prostatic patients are such

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garded by most operators who have occasionally employed this method. I have performed this operation over 100 times and have had but a single case of incontinence.

To briefly *summarize the subject of radical removal of the gland*, as I see it, bladder drainage, pre-operative preparation and study will establish how severe a tax may be imposed upon the individual patient within the probable limits of safety. I agree with Squire, Judd, and Young, that bladder drainage secured by the urethra is more satisfactory than by a suprapubic cystotomy. It imposes a less severe procedure at a time when all energy should be conserved. Bladder drainage is quite as satisfactory and if the suprapubic operation is chosen later, it is easier of accomplishment through the primary suprapubic incision than through a fistula established by the two-stage suprapubic operation. If catheter drainage cannot be secured *à demeure* suprapubic drainage is imperative for a period prior to the removal of the gland.

If, as a result of the pre-operative preparation, the patient proves to be an excellent risk, the suprapubic operation is chosen, because of the more rapid and satisfactory functional result. If, on the other hand, the patient's condition is proved to be below the standard required for the high operation, the perineal route is chosen. The best of this group may be subjected to the dissecting operation and the poorest to the median perineal enucleation method.

If the gland is proven to be of the small fibrous type, the perineal dissecting operation is the procedure of choice, even if the patient's condition is of the best, for the amount of prostatic tissue is small and intimately bound to the capsule surrounding the gland and most difficult to remove. I have often employed the technic of Proust; making a hemisection of the prostate along the floor of the prostatic urethra, but not ligating the ejaculatory ducts. The prostatic tissue is then dissected away, by enucleation, if possible; but more often cutting instruments are necessary. More recently I have not opened the urethra at any point, but have carried on the dissection through the prostatic capsule, clamping the prostatic tissue close to the urethra, as suggested by Rydygier, and then cutting it away. The results by this method have been more satisfactory as no perineal drainage of the bladder is required.

Glands proven to be carcinomatous are not dealt with in a radical manner, as the procedure is a severe one attended by a high mortality and is followed by a poor functional result. If, however, benign hypertrophy exists together with carcinoma, and the patient's condition is such as to permit of the removal of the benign portion, this should be

slough, which separates days and even weeks after operation. It may be controlled best, from above, by the Hagner bag, and from below by packing and a firm perineal dressing and the application of an ice-bag. Small irrigation of the bladder with astringents, rest, morphia and horse serum are of value. When it occurs in connection with a "punch" or "galvanocautery" operation, an ounce of adrenalin 1:5000 injected into the bladder usually suffices to control it.

So far I have never seen a fatal case of hemorrhage following any prostatic operation. The minimizing of bleeding is, however, important in conserving the patient's strength.

*Wound infection:* This applies almost entirely to the suprapubic operation, as the perineal approach is peculiarly free from this complication. A clean bladder medium to minimize the chance of infecting the wound, care not to traumatize the abdominal incision, and not to open the pelvis to any great extent by freeing the lateral walls of the bladder are features which play an important part in dealing with this complication. Complete hæmostasis of the bladder and abdominal incision, whereby infection is not invited from this source, is also to be considered. The fascia and skin should be carefully approximated by loose interrupted, non-soluble sutures, and the drainage tube should be left five days to wall off the adjacent tissues from the urine which will escape following its removal. Infection once taking place may result in sloughing of the rectus fascia and muscles, and, if reaching the pelvis, results in a pelvic cellulitis from which phlebitis and pyelonephritis are prone to occur. There is no more distressing complication, and unless the patient has much reserve strength an unfavorable outcome will result. The slightest evidence of infection calls for immediate and free opening and drainage of the field.

*Epididymitis:* This complication seems to occur frequently with some operations and rarely with others, and is dependent, in my opinion, to not keeping the scrotum well elevated throughout the entire convalescence. It is argued by some that it is prone to occur with urethral drainage, yet, while I have generally employed drainage in this way, it has occurred but rarely. As a rule, epididymitis following prostatectomy is unilateral, mild in degree, and rarely suppurates. It is, of course, a secondary infection, and freedom from it will depend upon keeping the urinary tract clean and the scrotum constantly elevated.

*Pyelonephritis:* This condition when pronounced following operation most frequently exists in some degree prior to operation. Infection in the kidney, even to the degree of pyelonephrosis, is not an uncommon associated feature to prostatic obstruction, and every attention should

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poor surgical risks that this bleeding is an important factor in lessening the patient's general resistances and that complete hæmostasis is most essential. As previously stated, my feeling is that cases vary considerably in regard to the amount of bleeding present, which is dependent chiefly upon the type of gland and the skill with which it is separated from the surrounding tissue. If there is any question of whether or not the bleeding is more than is safe to leave, there are several procedures that may be carried out to control it.

If the operation has been by the suprapubic route the Hagner bag is the simplest and quickest method of controlling the bleeding; for by its use the cavity from which the gland has been removed is filled by an even, firm pressure, and as the bag projects upward through the vesical sphincter bleeding from torn mucous membrane about the vesical outlet is also subjected to the same pressure. Applying a sponge soaked in boiling water, massaging the cavity with the finger, while it contracts, as done by Freyer, or sewing up the torn edges at the vesical sphincter are methods at our command. All are time-consuming and are only necessary in the exceptional case. As a rule, slight bleeding cares for itself by clotting, provided the bladder is not irrigated for twenty-four hours. Hæmostasis of the bladder wall and abdominal incision, however, should receive careful attention, for bleeding from these tissues is of real importance. When the bladder is much distended prior to the cystotomy, the vessels on its surfaces become more engorged than if the bladder distention is little. It is often difficult to avoid these vessels while opening the bladder, and care should be taken to see that any that are cut are included in the bladder suture. The same care should be given to vessels in the abdominal incision.

If the gland is removed by the perineal route, either by the dissection or median enucleation methods, a packing of gauze soaked in 1:10,000 adrenalin solution is placed in the cavity of the capsule on either side of the drainage tube, for the reason that by the dissecting operation the fibrous capsule of the gland, containing the venous plexus, has been opened.

When the "punch" or Bottini operation has been performed, a de Pezzer catheter drawn firmly into the vesical sphincter, thus making pressure on the incised areas, usually controls the immediate bleeding; yet following the "punch" operation I have been obliged, on a few occasions, to do an external urothrotomy to control the hemorrhage by a larger tube than could be passed through the penis.

*Delayed hemorrhage* occurs rarely but occasionally takes place most unexpectedly. It is usually due to the opening of a vessel by



and promptly prevent the deposition of alkaline incrustations. The urine should be kept acid at all times following operation, as the comfort of the patient will depend, in large measure, upon the absence of cystitis. As a rule, an active cystitis following operation is dependent upon the inability to empty the bladder entirely, or to the presence of concretions. When the operation has been undertaken without a cystoscopic or cysto- or cysto-ureteropyelogram a persistent cystitis is most likely to be due to a diverticulum, harboring an infected urine, with or without calculi. An example of this condition occurred in an elderly gentleman upon whom I did an emergency prostatectomy after twenty days' preliminary bladder drainage; with the result that following operation he had a foul residual urine of 18 ounces. Cystoscopy and a cystogram, when his general condition permitted, showed that a diverticulum, larger than the bladder itself, was present.

Cystitis following operation should receive attention. If a residual urine exists, further examination of the bladder is necessary to find the cause, and without a residual urine the bladder should be made as clean as possible by internal medication and local cleansing, with every attempt made to keep the urine acid.

*General Complications.—Shock:* Whatever operation is performed upon the aged is a factor which will tax the vitality, at least temporarily, and the more severe the operation the more the resistance is impaired. This is a matter for important consideration in most prostatic operations. The condition of the patient immediately following the operation will depend much upon the attention to details incident to the operation. The conservation of body heat, having everything ready before the patient receives the anæsthesia, giving the smallest amount of anæsthetic necessary to perform the operation, skill in its performance, and no delay or exposure in returning the patient to a well-heated bed will have an influence on the immediate reaction to the operation. Too much attention cannot be given to the establishment of confidence in the patient's mind as to the outcome of the operation. Many prostatic patients have the preconceived idea that death will be the result, not only because of a long period of suffering, loss of sleep, etc., whereby they see little worth living for, but because most men in the prostatic age have lost friends suffering from the same trouble, and in the period of distress their minds look forward to death as a preferable consequence. Without the establishment of a confidence for a favorable outcome the patient may make no effort in his own behalf; and, while perhaps this condition does not properly belong under the subject of shock, the mind plays no small part in influencing the con-

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be given to it in the pre-operative preparation, that whatever attention it may require following operation will be more responsive. Even when the pre-operative study has proven infection to be absent or of slight degree, an acute manifestation of the condition may take place even when there is no infection in the field of operation and the bladder is relatively clean. It may occur at any time during the convalescence, although its onset is usually a few days following operation. A failing appetite, dry, thickened, cracked tongue, a rising continuance septic temperature, a fall in the twenty-four-hour amount of urine, with or without chills and sweats or pains in the back, call for immediate attention in the way of forcing fluids, liquid nourishment, bowel cleansing, urinary antiseptics, and proctoclysis in the form of a 10 per cent. glucose solution; caffeine and whatever stimulation (probably digitalis) may be required. Pylonephritis is the concealed enemy to prostatic patients; nothing should be watched for more carefully, and the first sign of its presence demands the promptest and strictest attention.

*Cystitis:* This condition usually exists prior to operation, and continues in some degree following it. Naturally it varies with the permanent changes present in the musculature and mucosa of the bladder. It is generally admitted that patients without this complication prior to operation are poorer risks than those with a chronic bladder infection, to which they have been attenuated. It may be considered impossible to prevent cystitis in prostatic patients following the institution of bladder instrumentation, and those with a clear urine may be expected to develop a low-grade cystitis during the pre-operative drainage of the bladder. This is favorable, rather than otherwise, if the patient is not subjected to operation prior to the establishment of an immunization against it; for the bladder infection which otherwise must be expected, following operation, will occur at a time when the patient is in a less resistive state.

The treatment of the cystitis following operation consists in sufficient drainage and irrigations with potassium permanganate, silver preparations, boric acid solutions, and by preference alphozone. As the cystitis is usually of an alkaline type, an attempt should be made to render the urine acid by the ingestion of large amounts of fluids and the administration of ten to fifteen grains each of hexamethylenamin and acid sodium phosphate, in solution, every four hours. When this is not sufficient to accomplish the object, and alkaline salts become deposited on the drainage tube or the edges of the wound, the instillation of a concentrated solution of the lactic acid bacillus or the bacillus aciduricus will kill off the alkaline group of organisms, render the bladder acid,

impairment of the kidneys' power of elimination, and the presence of sepsis. As a rule, the patient's bowels should be moved on the third day following operation by the administration of Pluto water or Epsom salts, and at no time thereafter should the bowels be allowed to become constipated. If there is a tendency for this to occur, an anti-constipation diet and a daily cathartic should be employed. In no event, other than emergency, should enemata be administered. In marked stasis, hot poultices to the abdomen and pituitrin are of value, together with attention to any cause, such as sepsis, to which the stasis may be attributed.

*Hypostatic congestion and pneumonia:* Elderly persons confined to the dorsal position are most susceptible to pulmonary congestion and, following a general anæsthesia, especially ether, to a pneumonia. For this reason gas oxygen and spinal anæsthesia are, as a rule, the anæsthetics of choice. Patients naturally vary in regard to how much they may be advanced following operation; but every attempt, within reason, should be exerted to get them into the sitting position in bed, and to get them out of bed at the earliest moment consistent with their strength. A vigilance for lung complications is important, and if they take place they should be promptly recognized and appropriate treatment immediately instituted, even at the expense of interference with local conditions.

*Acute renal suppression:* While everything may have been done in the pre-operative preparation to establish a stable maximum efficiency of the kidneys, uræmia may, nevertheless, develop. It is observed in two types, either a diminished output of urine, probably due to the acute congestion of the kidneys, or a large output of urine of low specific gravity, probably due to interstitial kidney changes which result in an impaired power of eliminating effete products from the blood. The patient begins to lose interest, the appetite fails, he becomes drowsy, the tongue becomes thickened, dried and furrowed, hiccoughs may develop, the temperature falls below normal and he may gradually pass into a muttering delirium or coma in from twenty-four to forty-eight hours. The onset of these outward symptoms should be appreciated and treatment immediately begun to stimulate the activity of the kidneys, by giving digitalis intramuscularly, or caffeine sodium benzoate, grains two, every three hours by mouth; or by repeated injections of about a quart of salt solution or 10 per cent. glucose solution intravenously, subcutaneously, or as a constant rectal drip. If the kidneys fail to show proper response, stimulation of the skin by hot packs and the bowel by saline laxative must be employed as the means

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dition of shock incident to the operation. Not only is the establishment of a nerve block by local infiltration of value, as outlined by Crile, but when an operation is performed by local anæsthesia alone, the influence of the mind should be eliminated by some hypnotic, preferably scopolamine with a little morphia. This eliminates the fear incident to the immediate pre-operative hour and entrance to the operation room, prevents the activity of the mind during the operation, and leaves the patient with diminished sensibilities immediately following the ordeal. The shock incident to hemorrhage is a feature in itself and properly belongs under the subject of hemorrhage.

*Cardiac embarrassment:* While this condition is often present prior to operation, pre-operative attention by rest and other therapeutic measures, especially by the use of digitalis, leaves little to fear from this cause *per se*, unless there is pronounced evidence of a broken compensation which pre-operative treatment will not improve. Under these latter circumstances some relief other than a radical operation is indicated.

*Apoplexy:* This condition is not an infrequent accompaniment in prostatic patients, prior, as well as following, operation. I have several times operated upon patients who have passed through apoplectic attacks, without their recurrence following operation. On two occasions I have seen such attacks develop during the pre-operative preparation, without anything being done other than to establish bladder drainage by a catheter passed through the urethra. I have had three patients develop the condition following operation while still in the hospital. There is little that can be done other than to employ the usual, less severe, measures to lessen high blood-pressure.

*Embolus:* The entrance of a piece of blood-clot into the general circulation is a complication that occasionally occurs, and may result fatally. It is readily appreciated that clotted blood in the plexus of *Santorini* is to be expected, following the removal of the prostate. It is of importance, for this reason, to avoid large rectal injections in the form of enemata, and to avoid likewise constipated bowel movements following the operation. All immediate urethral instrumentation should be avoided, if possible, and, if necessary, undertaken with the greatest gentleness and with small and soft rather than hard, instruments, in order not to injure or dilate the prostatic area of the vesical sphincter.

*Intestinal stasis:* This condition is prone to occur, both because of the sluggishness of the musculature of the alimentary tract incident to old age, and because of the toxæmia which frequently accompanies

## CONGENITAL STRICTURES AND SPIRAL TWISTS OF THE URETERS\*

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IN my first and second papers<sup>1</sup> upon this subject, I reported four cases of congenital strictures of the ureter, and in a third communication<sup>2</sup> a fifth case was added. Of the first four cases, the stricture had not given rise to any clinical symptoms in one case, the specimen being obtained at the autopsy of a ten-days-old infant, who had died of icterus neonatorum. A second case of the first four occurred in one-half of a horseshoe kidney, and it was not clearly established at the time of operation whether the hydronephrosis was the result of a stricture at the ureteropelvic junction or of a faulty insertion of the ureter. In view of these facts, I have eliminated the two cases from my list and shall only consider as true congenital strictures the remaining three of my former cases which caused clinical symptoms, and can now add a fourth recent case to those previously reported.

A brief résumé of the most important facts in regard to my first three cases may be of interest before the details of the fourth case are given.

CASE I.—Boy of twelve. Referred on account of gradually increasing size of abdomen for past six years. Latter greatly enlarged, especially in left half, by soft elastic tumor lying behind inflated colon. No clinical symptoms except those of increased intra-abdominal pressure. At operation left kidney was found converted into an enormous hydronephrotic sac. Cause of obstruction was stricture of the ureter close to renal pelvis, which did not even admit a filiform bougie (*A* in Fig. 1). Uneventful recovery after nephrectomy.

CASE II.—Boy of fourteen, previously well, had sudden attack of left-sided abdominal pain with fever, localized rigidity and tenderness. Under deep anæsthesia, spindle-shaped swelling felt behind left rectus muscle. Upon opening abdomen, ureter found size of small intestine, very thin-walled and containing turbid urine. Local evidences of peri-ureteral infection. Ureter showed two points of narrowing, one close to renal pelvis of moderate degree

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## THE PROBLEM OF PROSTATIC OBSTRUCTION

of eliminating the toxic products which the kidneys are unable to care for. Success in dealing with this complication will depend only upon early recognition and intelligent treatment and nursing. When the patient is allowed to pass on to the stage of hiccough, delirium, and coma, recovery rarely takes place.

*Habits:* A knowledge of whatever eccentricities or habits the patient may have has a considerable bearing on the post-operative period. Aged persons who have come to rely on certain mental features and those who have been addicted to the use of tobacco, alcohol, tea or coffee had best be given all latitude, within reason, in the pursuit of such addictions. Everything should be done to allow the patient to live as near his usual methods as possible; for old established habits have much bearing, both mentally and physically, on the well-being of the patient.

### CONCLUSIONS

1. Prostatic patients form the most aged group of individuals commonly requiring surgical relief.

2. Pre-operative study and preparation renders the patient more suitable for the operation; or determines him to be inoperable.

3. No one operation is suitable for all cases, because of variation in the type of the gland, and because of the more important variation in the vitality of this class of patients. The appropriate operation for the individual patient should be chosen.

4. Details to conserve the patient's strength at all times are important.

5. Unusual vigilance in the post-operative period, the early recognition of complications, and immediate institution of appropriate treatment play a very important part in the convalescence and mortality.

cyst with twisted pedicle suspected, but the tumor disappeared to a great extent shortly after a catheter was introduced and a large amount of turbid urine obtained. A suprapubic swelling still remained however. A cystoscopic examination was considered in-

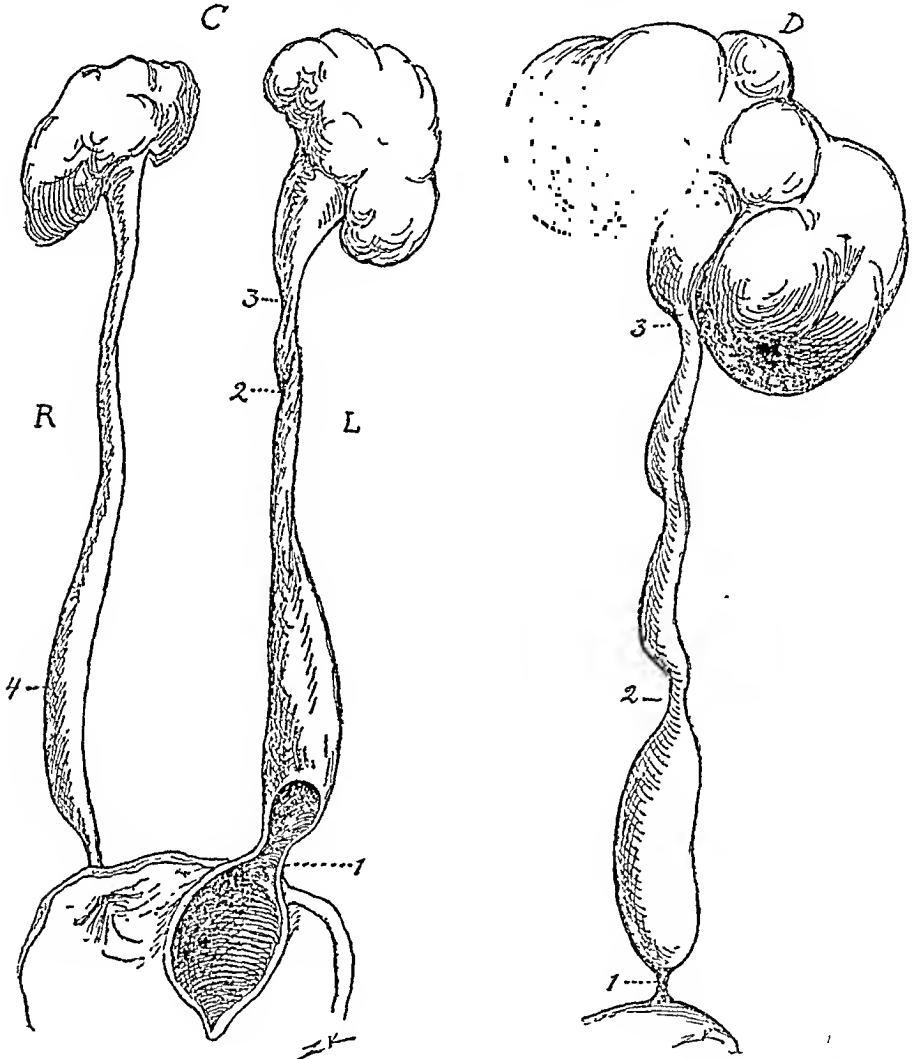


FIG. 2.—C, diagrammatic view of Case III. The cystic dilatation of the vesical end of the left ureter with a narrowing as it passed through the wall of the bladder is shown at 1. The spiral twist of the same ureter is shown at 2, and the narrow portion of the ureter at the ureteropelvic junction is at 3. The greatly dilated right ureter (4) was moderately stenosed above bladder, the chief cause of obstruction on right side being pressure of the intravesical cystic dilatation of the left ureter upon the right ureteral orifice. D, Case IV (see also Fig. 3) with impermeable stricture at 1 and narrowings at 2 and 3.

advisable, so abdomen was opened in median line. Both ureters and kidneys were found much enlarged (C in Fig. 2). The left ureter ended in a blind sac within the bladder and was dilated as far up as its junction with the renal pelvis, where a marked spiral twist of the ureter acted as a second cause of obstruction (Fig. 3).

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(*B* in Fig. 1) and a second one just above bladder. At the latter point the ureter suddenly changed (*B* in Fig. 1) in size and became a fibrous cord for a distance of one inch. Through this stricture a very fine probe could still be passed. The kidney showed a moderate degree of hydronephrosis, but in the cortex

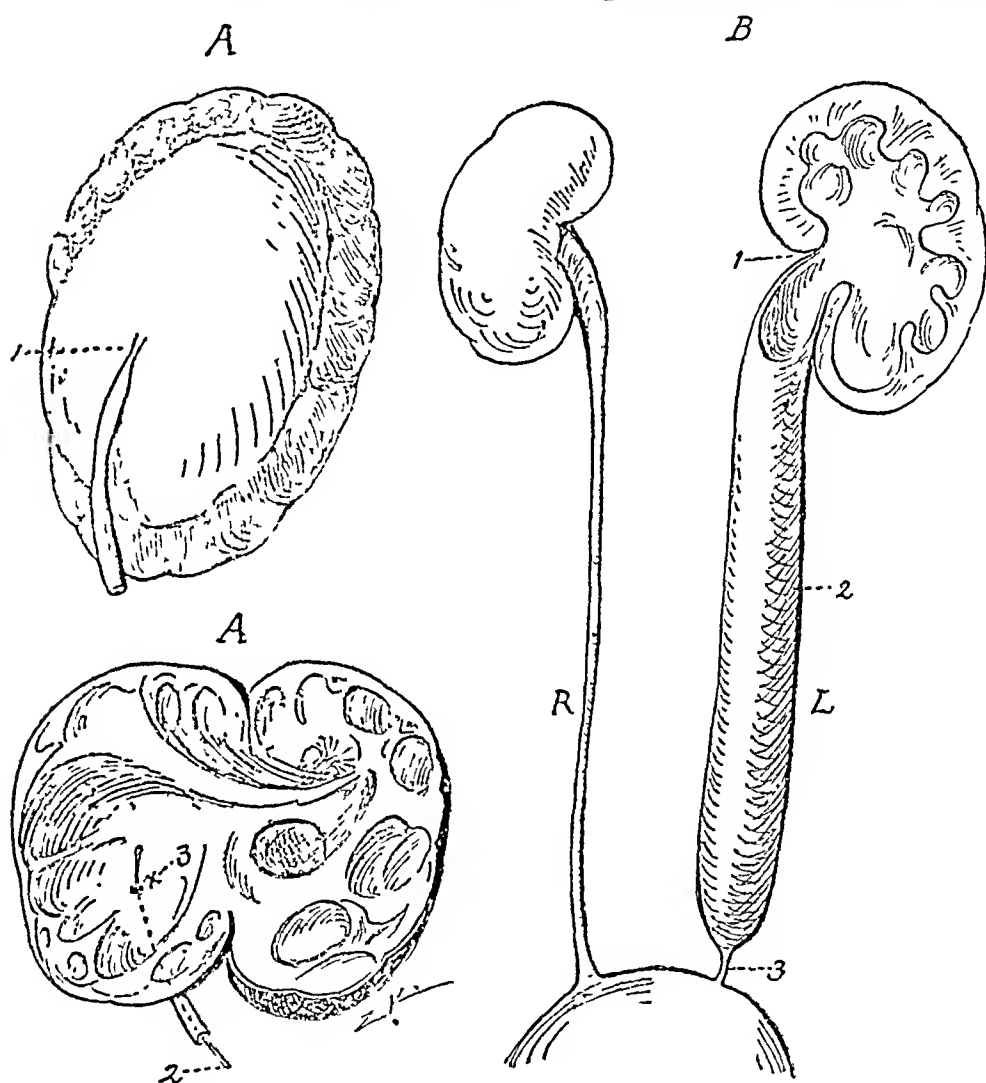


FIG. 1.—A, exterior and interior of kidney from Case I, showing location of stricture at ureteropelvic junction (1). The narrow opening of the ureter into the renal pelvis is shown at X near 3 in lower illustration of A. 2 represents probe inserted through the stricture into dilated renal pelvis. B, diagrammatic view of Case II, showing slight narrowing of the greatly dilated left ureter (2), at ureteropelvic junction (1), and almost complete obliteration just above bladder (3).

there were a number of small abscesses. Recovery after nephrectomy and ureterectomy.

CASE III.—Girl of sixteen with stigmata of cretinism was admitted to the hospital on account of severe pains in abdomen accompanied by vomiting. These symptoms had appeared suddenly about two weeks before admission. At the first examination an enlargement in the suprapubic region was felt and an ovarian



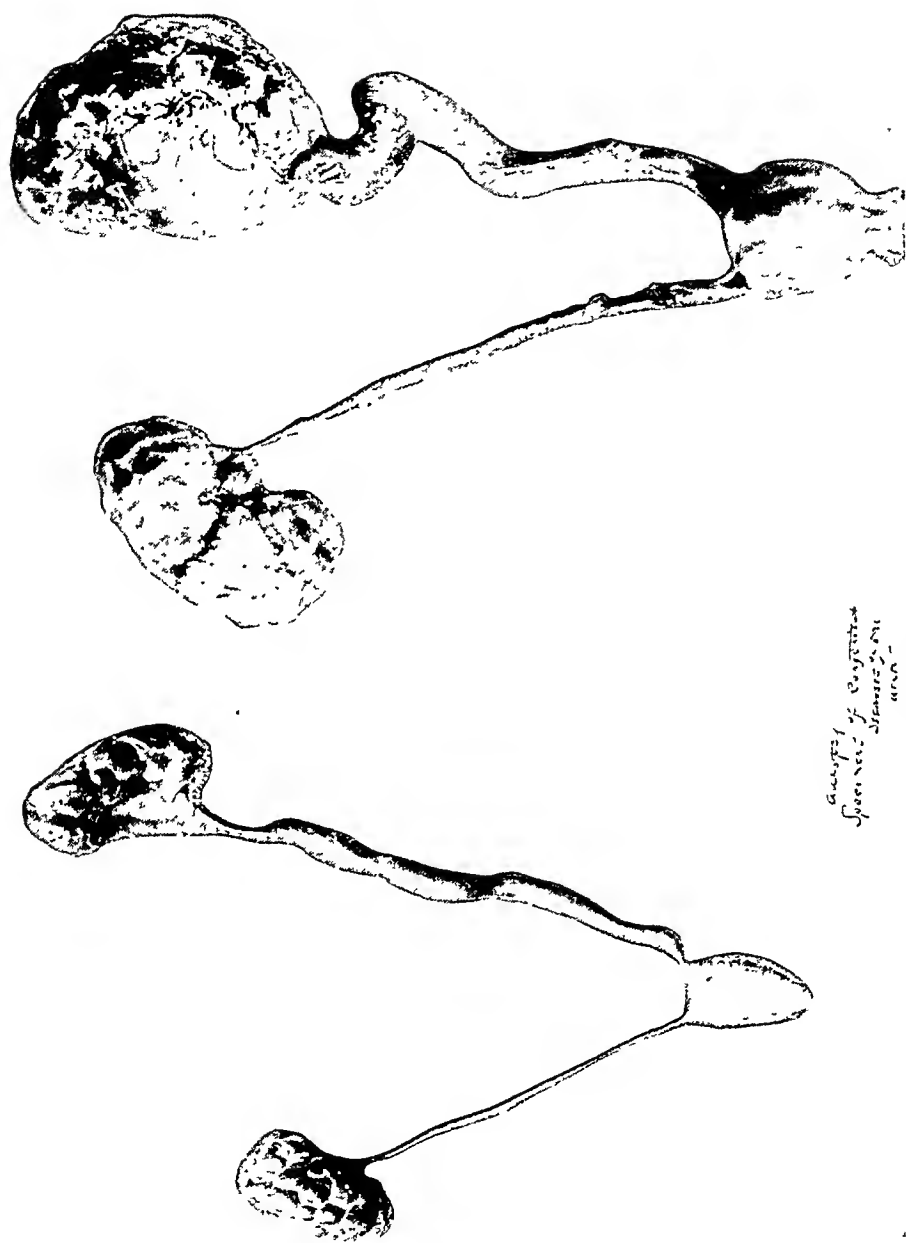


FIG. 5.—Two specimens showing congenital strictures of the ureter obtained at autopsies of infants by Dr. H. O. Mertz of La Porte, Ind. Specimen on left shows stricture near bladder and just below renal pelvis in left ureter. Specimen on right shows marked dilatation of entire left ureter and renal pelvis with closed lower end of ureter, as in author's Case III.

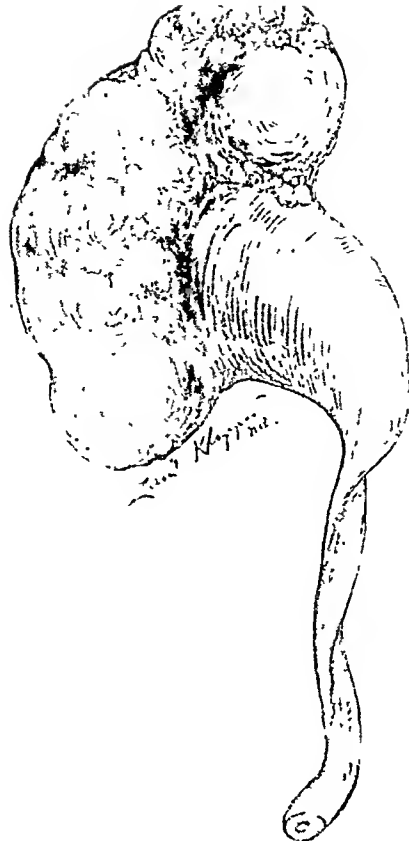


FIG. 3.—Ureter of Case III, showing spiral twist at junction of upper and middle thirds, with resultant obstruction of renal pelvis.



FIG. 4.—Photograph of kidney and ureter of Case IV. Note advanced degree of hydronephrosis with constriction of ureter of moderate degree close to renal pelvis and complete obliteration of lumen above the bladder. The ureter just above this impermeable stricture was the size of the small intestine.

hydronephrotic sac which extended from the brim of the true pelvis to the diaphragm and forward to the median line. The fluid within this enormous kidney was under great tension and had to be evacuated (as in Case II) before the thin-walled sac could be brought into the incision. The ureter was distended to the size of the small gut down to a point about one inch above the bladder, where it terminated abruptly in an impervious fibrous cord (Fig. 4).

The kidney and entire ureter were removed and the wound closed in usual manner. No accessory arteries were found. The kidney after removal represented an extreme degree of hydronephrosis, the cortex being so thin that it would have ruptured spontaneously unless operation had been done. The walls of the greatly dilated ureter were relatively thick. There were two points of slight narrowing above the seat of stricture, one of these being close to the renal pelvis and a second where the ureter crossed the iliac vessels. At the lower end, however, the lumen ended abruptly, and the fibrous cord-like portion which represented the stricture had no lumen. There were no valves in the lumen and no spiral twist in the portion above the stricture as in Case III.

*Review of chief points of interest in author's four cases:*

1. *Location of stricture.* In Case I, there was a slight one close to renal pelvis and a second one, more marked but permeable, just above the bladder. In Case II the stricture was impermeable and located at the ureteropelvic junction. In Case III there was an intravesical pouch formed by the obliterated lower end of the ureter and a second obstruction in the form of a spiral twist just below the kidney. Case IV greatly resembles the second case, the stricture being located in the juxtavesical portion of the ureter, but being impermeable.

2. *Effect on ureter and kidney.* Except in Case II, where the stricture was near the kidney, the ureter was greatly dilated in all. The hydronephrosis was most marked in Cases II and IV, where the strictures were either impermeable or nearly so.

3. *Clinical symptoms and pre-operative diagnosis.* The first symptoms appeared at puberty in all of the cases and were due to infection. Abdominal pain, sudden in onset, dominated the clinical picture of infection except in Case III, where the suprapubic enlargement was a very striking finding. A diagnosis before operation of congenital stricture of the ureter with secondary hydronephrosis was only made in Case IV. In Case II, the diagnosis was hydronephrosis, but the ureteral stricture was not recognized until operation.

4. *Effects on bladder.* No bladder symptoms except in Case III,

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A plastic operation was first performed on the closed vesical end of the ureter, and later a ureteronephrectomy on this side. Patient died of uræmia five months after the second operation. The right ureter showed, at autopsy, a narrowing just above the bladder with marked dilatation of the remainder of the ureter and of the renal pelvis.

A fourth case has been recently observed which I desire to add to the three preceding ones.

CASE IV.—Male, aged twenty-six, referred by Dr. I. B. Diamond of Chicago, with diagnosis of left-sided renal infection. History of recurrent attacks of left-sided abdominal pain since age of fourteen. At first, the attacks would recur at intervals of six to eight months, the pain being of a dull aching character, radiating from a point a little to the left of the umbilicus towards the left kidney region and lasting about six to seven hours. During these attacks he noticed considerable left-sided abdominal enlargement with vomiting and marked constipation. He had never observed any disturbances of urination. He had only two attacks during the five years preceding the one for which he was sent to hospital. One of these two attacks had continued for nearly two months.

Upon admission to my service at the Michael Reese Hospital on February 14, 1917, he stated that the present attack of left-sided abdominal pain had begun suddenly about two weeks before. Examination revealed a soft elastic enlargement on the left side of the abdomen, extending from the level of the anterior superior spine of the ilium below to the costal arch above and disappearing under the latter. The ability to palpate the rounded lower and inner borders of the soft elastic enlargement and its location behind the inflated colon led me to conclude that a very large hydronephrotic sac was present, due to some form of ureteral obstruction. There was a moderate degree of leucocytosis and rise of temperature. Radiography of the urinary tract was negative. Cystoscopic examination showed the bladder to be normal except for a slightly prominent left ureteral orifice. Catheterization of the right ureter was easily carried out and showed a normal, functioning kidney with an excretion of 24 per cent. phthalein in the first hour. On the left side there was complete obstruction of the lumen of the ureter at a point just above the bladder. Even a filiform ureteral catheter could not be passed through the strictured portion; so all attempts to make a ureterogram were abandoned. The diagnosis was made of a congenital stricture of the ureter in its pelvic portion with secondary hydronephrosis.

At operation (February 18, 1917) we exposed the kidney through the usual incision. The kidney was represented by a

tissue. In some cases the ureter is stenosed at the point where valves are found, and in all probability the valves play a rôle here.

*Clinical Importance.*—The presence of the narrowings, twists, and valves, as found in the normal fetal and adult ureter, was formerly thought to be of interest to the anatomist and pathologist alone. Although a number of the cases collected by Bottomley were reports of specimens found at autopsy, yet in quite a large number the persistence of these congenital conditions gave rise to symptoms requiring operative measures.

In several of the cases collected by Bottomley, a portion of the ureter was wholly fibrous, while in others the ureter was impermeable throughout and was represented only by a fibrous cord, a functionless ureter. Teyssedre<sup>9</sup> collected reports of eleven such cases. The fibrous ureter may lead to absence of the kidney or of the whole or a portion of the ureter. In eight cases of Bottomley's series the stricture was located in the upper third of the ureter, usually at or close to the opening into the renal pelvis.

In 36 of 56 cases the obstruction was in or very close to the bladder; 17 of Bottomley's cases had vesical protrusions, 39 did not. Nichols's and Lower's cases showed a stricture both at the upper and at the lower end of the same ureter. A single ureter may present alternating portions with and without a lumen.

The most important, and, in their effects, the most far-reaching modifications of form are seen in the obstructions at the lower end of the ureter. In these the ureter usually reaches the bladder, but in most instances ends there in a blind sac. The protrusions range in size from that of a small pea to one completely filling the bladder lumen. Usually (in 12 out of 17 cases) the protrusions are blind cul-de-sacs without an opening into the vesical cavity. In five cases there was a communication between the protrusion and the vesical cavity, almost invariably by minute openings at the tip or on the side of the former.

*Effect on Ureter.*—When the obstruction is at the lower end, the ureter is almost invariably dilated, thin-walled, and tortuous. It varies in size from that of a pencil to that of the small intestine.

*Effects on the Renal Pelvis and Kidney.*—Either an enormous hydronephrosis or a most marked primary atrophy may result from ureteral obstructions of the same location and character. Hydro-nephrosis of varying degree is the rule.

*Effects on the Bladder.*—The cystiform protrusions of the blind-ending ureter into the bladder may cause marked secondary pathologic changes in the bladder, as well as in the other ureter, or in the other kidney, as in Case III. The protrusion may block the opening of the

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where the intravesical cystic dilatation of the left ureter gave rise to retention and also to pressure on the right ureteral orifice and favored ascending renal infection on that side.

*Review of Literature.* The most complete article upon this subject is that of Bottomley<sup>3</sup> in which fifty-six cases reported up to 1910 are collected. Including the fifty-six cases collected by Bottomley, four of my own and seven published since 1910, a total of 67 cases are now on record. One of the most interesting of the cases which have caused clinical symptoms is that of Lower.<sup>4</sup> His patient was a boy of eighteen with frequent attacks since infancy of left-sided abdominal pain. The last attack was accompanied by severe pain, chills and fever. Radiography showed the shadow of a calculus in pelvic portion of left ureter. It was extremely difficult to find the calculus at operation because it migrated easily within the lumen of a widely dilated ureter. This dilatation had taken place between two congenital constrictions of the ureter, one close to the bladder and a second one near the renal pelvis.

*Etiology.*—This is not quite clear, but is best explained as either the result of the persistence of fetal conditions or a retardation of development of structures destined to perform important functions.

*Persistence of Fetal Conditions.*—Seitz,<sup>5</sup> Byron Robinson,<sup>6</sup> Hamann,<sup>7</sup> Caspar,<sup>8</sup> and others have shown by their studies of the normal ureter, in the foetus and at different periods of post-uterine life, that the ureter in all mammals possesses certain more or less constant points of narrowing and of dilatation. In addition, the occurrence of valves and of twists or tortuosities is not at all uncommon, especially in the fetal ureter. Fig. 5 shows where these various conditions most frequently occur. The points of narrowing are as follows:

(1) Just before the ureter enters the bladder wall; (2) where the ureter crosses the pelvic brim; (3) close to the pelvis of the kidney:

These three points of narrowing become more marked toward the end of fetal life, as Seitz has shown, and were constantly found in the normal adult ureter by Robinson.

The dilatations are always found on the proximal side of these narrowings in the normal human foetus. The most marked widening is situated in the middle third of the ureter, *i.e.*, proximal to the narrowing which occurs at the pelvic brim or between it and the bladder wall.

The spiral twists occur at any point, but are most marked at the junction of the upper and middle thirds of the ureter, as in my Case III. The rôle which valves play in the production of stenoses is not quite clear. They are found in about 20 per cent. of cadavers of normal children, and contain mucous membrane, submucous and muscular

# OBSERVATIONS ON ANOMALIES OF THE URINARY TRACT

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ANOMALIES and malformations, mostly of congenital origin, are found in any organ or region of the urinary tract. While the occurrence of these abnormalities of form, position, and number, and particularly those of and above the bladder, is comparatively rare, they assume, nevertheless, great practical interest on account of the appalling diagnostic difficulties they often present to the urologist.

CASE I.—*Renal hypoplasia (rudimentary kidney) and hydro-ureter on the left side.* About ten years ago a man of thirty-five came under observation with the following history: Five years before, shortly after an attack of gonorrhœa, frequent and painful micturition set in. Since that time his urine was always turbid, of strong odor, and containing a heavy sediment of almost pure pus. During that time he had been under almost constant treatment, and at various clinics had undergone several operative procedures without material relief.

The patient looked emaciated and cachectic. His intellect was rather dull. On inspection a longitudinal scar was visible above the pubic symphysis and two horizontal scars with central fistulous openings, emitting turbid fluid, were situated in both iliac fossæ. Irregular septic temperature. Kidneys not palpable. Physical examination negative. Prostate normal per rectum, seminal vesicles not palpable. Urinalysis: Very cloudy urine, slightly acid, low specific gravity, abundant microscopic pus, many blood-cells, no tubercle bacilli; guinea-pig test negative. Radiography negative for renal or ureteral concretions. Cystoscopy: Bladder capacity very small, later on gradually increased to 50 c.c.; bladder wall markedly trabeculated and ulcerated; landmarks of trigone impossible of identification on account of rapid clouding of irrigating fluid.

After many sittings, spent in laborious and systematic search of every groove and slit suggestive of an ureteral orifice, the right ureter was entered by chance, and the catheter pushed forward to the renal pelvis. The right-sided renal secretion revealed fairly satisfactory values for urea and sugar after phloridzin; indigo-carmin appeared after fifteen minutes and showed a good color-index half an hour after injection of the

opposite ureter. In other cases it may wholly obstruct the vesical opening of the urethra, give rise to a distended hypertrophied bladder and then the usual sequelæ of retention of urine result. Both the right ureteral orifice and the internal meatus urethræ were blocked by the cystiform protrusion in Case III and the bladder walls greatly hypertrophied.

*Symptoms and Diagnosis.*—A survey of all the published cases of congenital anomalies of the ureter shows that clinically they belong to one of four classes: (1) Those in which the condition remains latent throughout life and is an accidental finding at autopsy. The majority of the published cases belong to this class. (2) Those in which the presence of an abdominal tumor, which may or may not be diagnosed before operation as being of renal origin, is found when the abdomen is opened. (3) Cases in which the predominant symptoms are those of an abdominal infection. The clinical picture may resemble that of an acute infection of one of the intraperitoneal viscera, or it may point more directly to the kidney and ureter as the source of the symptoms of infection. (4) Those cases in which disturbances of micturition are the principal symptom. This consists either of increased frequency or retention.

The examination of the urine is of little value, unless infection has supervened, and even then there is nothing to be found. Ureterography and pyelography and the other methods used in the diagnosis of ureteral strictures and of hydronephrosis are of the greatest value when the stricture is permeable.

*Treatment.*—The treatment depends, first upon the degree of constriction; second, upon the damage to the kidneys due to the ureteral obstruction; and, third, upon whether infection is present or not. In the latter class of cases nephrectomy is, as a rule, the only method of treatment. If the kidney has not been too greatly damaged, it may be possible to perform a pyelo-ureteroplasty or implant the ureter into the bladder from a point above the stenosis.

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- <sup>3</sup> ANNALS OF SURGERY, 1910, lii, 597.
- <sup>4</sup> Amer. Journ. Urology, 1913, ix, 27.
- <sup>5</sup> Beitrage zur Geburtshilfe u Gynakologie, vol. xiii.
- <sup>6</sup> Anatomischer Anzeiger, vol. xii.
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- <sup>8</sup> Archiv für klinische Chirurgie, 1915, cv, 251.
- <sup>9</sup> Thèse de Paris, 1892.



The specimen containing the upper end of the ureterorenal sac showed a slight widening at its upper half, which measures about 2.5 by 2 cm.; when opened, the mucous membrane appears to be smooth, separated by a few horizontal folds, and covered with mucopurulent shreds; no renal pelvis or renal tissue could be ascertained on macroscopic inspection. Dr. Ophüls' report upon the histological examination was as follows: "Nothing of kidney tissue found. The specimen shows connective tissue of involuntary muscle fibres." Nothing suggestive of a renal pedicle could be traced. No vestige of an adrenal gland was found.

The specimen was, unfortunately, lost at the pathological laboratory and, therefore, cannot be reproduced in this connection.

The patient made a slow, but uneventful, recovery. His general condition and urinary symptoms improved materially, though the urine remained cloudy and always showed microscopic pus. Cystoscopy, several months after the operation, revealed marked increase in capacity (150 c.c.), the landmarks of the trigone could now be recognized, the right ureteral orifice was normal in size and spurt, while at the site of the left meatus a diverticular opening of about 2.5 cm. diameter was noticeable, into which a ureter-catheter could be pushed forward a distance of about 25 cm., corresponding to the point at which ligation of the dilated ureter had been done.

The fistulæ in the iliac fossæ had closed soon after the operation, while that in the loin remained open for several months. An attempt to close that fistula by paraffin injections resulted in the formation of a concrement in the bladder, which, later on, was recognized cystoscopically and removed by means of the lithotrite.

About a year after the operation the patient returned from a long sojourn in the mountains, much improved in health and strength, and with the fistula in the left loin entirely closed. His bladder capacity had increased to about 250 c.c., frequency in micturition was slightly increased, urine somewhat cloudy, containing a small amount of microscopic pus; his bladder contained about 50 to 100 c.c. residual urine; cystoscopy revealed an almost smooth bladder mucosa and a moderate cystitis, while the findings at the trigone were identical with those noted above.

The patient was now able to resume his usual occupation.

During the next two or three years the patient's urinary symptoms gradually increased in intensity, while his ability of spontaneous evacuation of urine had markedly diminished, the bladder always containing between 200 and 300 c.c. of cloudy, purulent and malodorous urine. In spite of careful local treatment, including direct irrigation of the dilated left ureter by means of a large

dye; microscopically a number of pus-cells, small round epithelial cells, some of them degenerated, and fresh blood-cells (due to ureteral catheterization) were recognized.

In spite of most painstaking and often repeated search, the left ureter could not be identified. At times the ureter catheter seemed to slide forward almost its whole length into some groove or hole situated in the region of the left ureteral meatus, but, on account of the almost instantaneous clouding of the field of vision, a decision upon the whereabouts of the tip of the catheter could not be reached. A faintly blue-colored fluid, containing traces of urea and phloridzin-sugar, and in the sediment of which, microscopically, besides pus a few element of renal significance were ascertained, was collected from the catheter. A similar result was obtained from the attempted study of the relative functional and microscopic findings by means of a ureter-catheter *in situ* in the right renal pelvis, and a bladder catheter representing the secretion of the left kidney.

The clinical symptoms and cystoscopic findings, incomplete as they were, obviously pointed to the existence of a left-sided pyonephrosis, resulting in complete destruction of the kidney on that side. On account of the rapid deterioration of the patient's condition, removal of that organ was decided upon.

In chloroform narcosis the usual incision for exposure of the kidney was made in the left loin, which was carried down to the transverse fascia; but in spite of careful search no organ of the size, shape or consistency of kidney was found. In scanning the operative field in various directions, the peritoneum was opened, and various parts of intestine and the spleen were palpated and recognized.

After closing the peritoneum, the incision was extended downward and forward for exposure of the ureter. An oblong-shaped body, located outside the peritoneal sac, of soft consistency and surrounded by a great deal of connective tissue, was thought to be, in all probability, the ureter, though, on account of its width, it could not with safety be differentiated from intestine (ascending colon). With this doubt in mind, a small incision was made in its wall, through which a catheter was pushed down the tube; colored fluid, injected through this catheter, was recovered from another catheter lying in the urethra, proving by these means the identity of the tube with the left ureter.

The operation by this time had lasted unusually long, and the precarious condition of the patient made its rapid termination imperative. The upper end of the ureter was, therefore, freed from surrounding adhesions with the utmost despatch; it was then ligated and removed; closure of wound in usual manner.



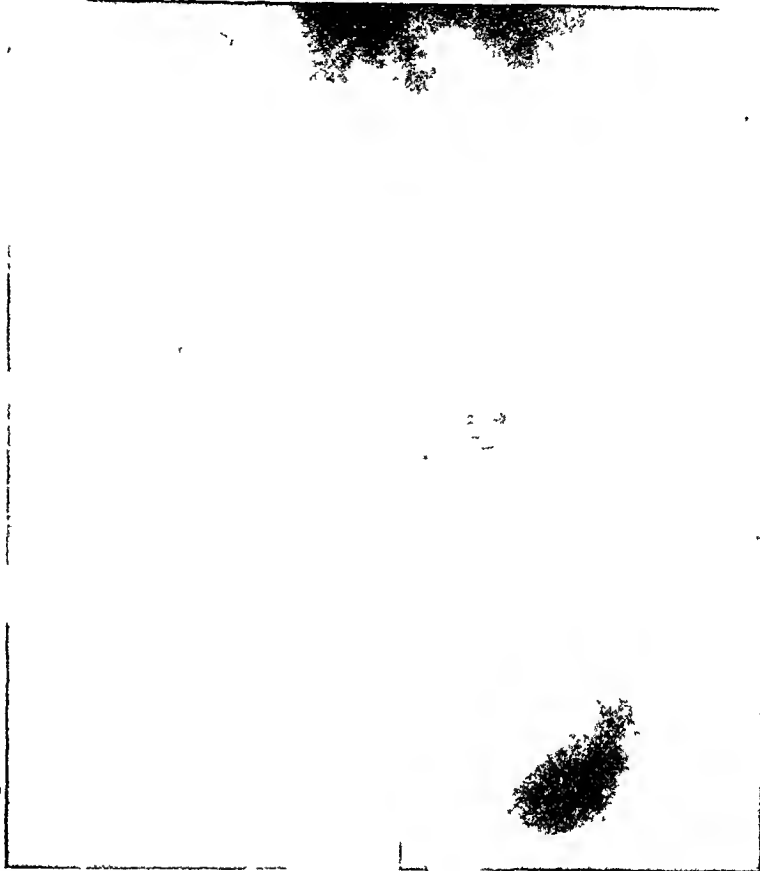


FIG. 1.—Hydro-ureter.



FIG. 2.—The excised ureter.



FIG. 3.—Showing stump of ureter.

According to their structure, the examined specimens were mostly composed of dense connective tissue. In the few cases in which a microscopic examination was made, only small islands of well-formed renal tissue could be differentiated from the surrounding mass of fibrous tissue. In one case reported by Tissède,<sup>6</sup> a few isolated glandular acini, but no glomeruli, were found. Neither could Eppinger,<sup>7</sup> on painstaking microscopic study of his case, detect in his slides true glomeruli, though he found a few collecting tubules.

In the majority of cases of renal hypoplasia, like in my own case, no renal pelvis existed. The ureter was either missing, or it was an entirely impermeable fibrous cord, or it possessed a very narrow and partially obliterated lumen affording no communication with the bladder.<sup>8</sup> Boström<sup>9</sup> directed attention to various anomalous conditions at the lower end of the ureter, which are particularly frequent in cases of renal hypoplasia connected with duplication of the ureter. According to Küster<sup>10</sup> the ureter in renal aplasia, or congenital renal atrophy, frequently ends blindly either above or below; its width varies between that of a hair or of a large sac. Unusual shortness of the ureteral channel is generally connected with an abnormally low position of the kidney, while cases of atrophic kidney, complicated by ureteral duplication, present an abnormal length of either of the two ureters. Abnormal width of the ureteral channel, without the presence of an impediment to free urinary flow, is, according to Meckel,<sup>11</sup> always indicative of persistence of fetal development of the ureter, which, also, under normal conditions, in the mature foetus is comparatively much wider than in the adult.

Of practical interest, as regards the frequency of the condition, is Morris'<sup>12</sup> statement that aplastic and hypoplastic kidney occur in about 0.02 per cent. of normal kidneys.

Küster<sup>13</sup> differentiates two groups of rudimentary kidney according to their development. In the first group either the whole or a part of the anlage of the kidney has suffered developmental arrest at a very early stage, while the second group comprises those cases in which the kidney possesses normal form and structure, but is abnormally small (atrophic kidney).

My own case evidently belongs to the first group. Developmental arrest of the left kidney and ureter, in all probability, must have occurred at a very early stage of fetal or post-fetal life. Owing to huge dilatation of the left ureter, infection of the tube and its hypoplastic renal appendix was established at the first provocation (cystitis colli after gonorrhoeal infection) and of necessity became irreparable; by

calibered ureter-catheter, uroseptic symptoms, increasing in gravity, set in. A pyelogram made at that time revealed the irregularly shaped bladder shadow, from the left side of which the shadow of the hugely dilated ureter was seen to rise above the bony pelvis (Fig. 1).

In spite of the patient's unsatisfactory condition and his reluctance to additional surgical procedures, the removal of the left-sided hydro-ureter was decided upon.

In gas-ether narcosis by an incision, carrying the original loin incision downward and forward, the ureter was extraperitoneally dissected to a point about 2 or 3 cm. above the bladder, where the tube, unfortunately, tore off. The wound was closed, leaving a small fistula for a gauze drain, carried to the stump of the ureter. The length of the excised ureter was 21 cm., its width was of variable calibre, measuring at its maximum 2.5 cm. (Fig. 2).

The patient made a slow recovery. A pyelogram taken about six weeks after the operation shows the stump of the left ureter (Fig. 3).

At his discharge from the hospital, the patient was able to evacuate his bladder completely; urine almost clear; general condition rapidly improving. He resumed his occupation in the country, from where he sent several satisfactory reports upon his condition.

In the fall of 1916, about six months after the last operation, the information reached me from a hospital in a Northern Californian town, that the patient had died there, two days after operation, for strangulated hernia, incidental to fall from a horse.

Hypoplasia or rudimentary development of the kidney, according to Ballowitz,<sup>1</sup> represents the comparatively most frequent renal anomaly. The first authentic case of that type recorded in the literature dates back to the year 1677,<sup>2</sup> while the next case was reported almost 200 years later by Sidney Jones.<sup>3</sup> Since then quite a number of similar cases have been published. An analysis of the reported cases does not reveal particularly interesting data as regards age or sex. Only in a few instances an abnormal location of the hypoplastic kidney is noted, as in Rosenberger's<sup>4</sup> case, where the rudimentary organ was situated within the bony pelvis to the right of the rectum. As regards its size the hypoplastic kidney is, in most instances, compared to a walnut, flattened disc, or a bean. Measurements, where they have been recorded, give the length and width of the largest specimen as 4.5 by 1.5 cm., while measurements of the smallest specimen were 1.5 cm. by 7 or 8 mm. As regards weight, I can only find one reference,<sup>5</sup> in this the specimen weighed less than 1 gramme.

the twelfth rib, and suggestive of a position at or near the renal pelvis. Pyelography, though repeatedly done, did not materially aid the diagnosis, as almost all of the injected silver solution ran back into the bladder; thus only the hazy outlines of slightly dilated renal pelvis were thrown on the plate.

Upon these findings the diagnosis of bilateral nephrolithiasis with secondary infection and destruction of the right kidney (pyonephrotic stone kidney) was made. For obvious reasons and particularly on account of the patient's precarious condition, drainage of the right organ was considered the first and most imperative operative procedure.

*Operation.*—By the usual right-sided lumbar incision the upper pole of the kidney was easily freed; luxation, though, of the lower pole seemed impossible, wherefore the incision was materially enlarged; the kidney was now found to extend downward to the left side of the abdomen toward the bony pelvis. The right half of the kidney, which was, by that time, recognized as of the fused or horseshoe type, was brought up into the incision and found to contain a pus cavity. A calculus of the size of a large olive pit was felt in the renal parenchyma just above the pelvis, and removed by a small incision, which was afterwards closed with catgut sutures. The pyonephrotic sac was incised, emptied and drained by a rubber tube. The kidney was replaced and the wound drained by cigarette drains at its upper and lower ends. Closure of wound by layers.

The following notes were taken three days after the operation: Patient rallied well from the operation. Temperature, 99°; pulse, 100, volume, fair; general condition good. Only a few ounces of purulent urine are thus far obtained by catheter. Bandages wet. All efforts, though, to increase diuresis failed, and the patient died about a week after the operation, under uræmic and septic symptoms.

Important items of the autopsy pertaining to the genito-urinary tract are:

No break in peritoneum over kidney, and the loose tissue around it shows hemorrhagic infiltration.

Bladder filled with thick, creamy pus, ureteral openings normal on both sides; right ureter runs up in normal direction.

Kidney is of horseshoe variety, whose right pyonephrotic half is drained by an incision, in which is a drainage tube.

There are two renal arteries slightly smaller than normal.

The two adrenals are in normal position.

Death was, according to the autopsy report, due to infection of the loose tissue around the right half of the kidney, recent peritonitis and bronchopneumonia.

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these means destruction of any real parenchymatous tissue present in the kidney occurred, and a condition identical with complete renal aplasia ensued.

These deductions, though, are merely of academic interest; from the standpoint of practical surgery the differential diagnosis between renal hypo and aplasia is of no import, since the former condition always produces an anatomically and functionally valueless organ.

Pyelography, which was not available at the beginning of my observation, would in all probability have given important additional diagnostic data, so that ureterectomy could have become feasible in one sitting. I doubt, though, whether an exact pre-operative diagnosis would have been possible on the basis of pyelographic evidence.

CASE II.—*Horseshoe kidney (fused type); bilateral nephrolithiasis; pyonephrosis of right side.* About five years ago a man of thirty-two entered the hospital on account of severe pyuria and intermittent attacks of right-sided kidney colic. No important data as regards previous affections of the genito-urinary tract could be elicited from the history. The patient, who is an enthusiastic mountain climber, noticed the first untoward urinary symptoms shortly after an unusually hazardous mountain trip, which occurred only a few weeks prior to his admission to the hospital.

Physical examination negative. Kidneys not palpable. Irregular septic temperature, between 100 and 102° F. Daily urine quantity about 500 c.c. Urine cloudy, containing mass of microscopic pus; daily urea quantity about 15 grammes or less. Patient slightly comatose.

Cystoscopy demonstrated a moderate cystitis; both ureter catheters could be pushed forward as far as the renal pelvis, but no fluid was coming forth from the right, and very little urine was collected from the left renal catheter. Finally, after several cystoscopic sittings, which were unsuccessful as regards obtaining material for comparative functional and microscopic study, a few drops of almost pure pus were withdrawn by suction from the right renal catheter. The comparative examination gave the following result:

Right	Left.
Sugar (after phloridzin) 0.0 per cent.	0.1 per cent.
Urea ..... 0.001 per cent.	0.031 per cent.
Microscopic: Almost pure pus; a few small round epithelial cells.	A few pus-cells, many small, round epithelial cells, many blood-cells.

Palpation of kidneys negative. Radiography showed typical concrement shadows in both kidney regions, almost symmetrically located to both sides of the second lumbar vertebra, a little below



the opinion of various observers, may, under favorable conditions, afford the chance of establishing the pre-operative recognition of fused kidney. A brilliant observer like Israel<sup>10</sup> was by these means able to diagnose hydronephrosis of the right half of a horseshoe kidney before operation, but this is the only pre-operatively recognized case that I can find in the literature. In my own observation none of the symptoms enumerated above were present, and especially the radiographic findings were barren of diagnostic significance, since both stone shadows appeared on the plate at a distance of several centimetres from the spine.

It seems to me, though, as if the pre-operative diagnosis would be feasible in some instances by considering in every obscure renal lesion the possibility of its being due to fused kidney. It will be conceded to be an irrefutable fact, however obvious the statement may appear at first glance, that in order to diagnose a certain pathological condition one has to bear in mind the probability of its existence. Where, like in my case, an otherwise inexplicable incongruity exists between onset, duration and gravity of clinical symptoms, by which my young and robust patient was seized quite suddenly, and which in such intensity are rarely observed in uncomplicated nephrolithiasis, the possibility of horseshoe kidney should at least be taken into consideration, and investigations, carried on with that view in mind, might, occasionally, lead to diagnostic success.

CASE III.—*Double bladder in a prostatic; ascending pyelonephritis.* A man of seventy-three came under hospital observation on account of frequent and painful urination which had started about four years before and gradually had increased to almost unbearable intensity. Physical examination revealed mitral insufficiency and arteriosclerotic changes, symptoms of urosepsis; irregular temperature between 99° and 101° F., drowsiness. The bladder contains about 120 c.c. of very cloudy residual urine, showing microscopically abundant pus, degenerated small round epithelial cells and a number of hyaline and granular casts.

Prostate per rectum moderately enlarged. Two hours' phthalein output about 30 per cent. Cystoscopy, which was at first impossible on account of severe bladder irritability, when finally feasible, showed an irregular sphincter, a trabeculated and cystitic bladder wall, and, with the beak of the Nitze cystoscope pointed upward, on the posterior bladder wall, a diverticular opening, measuring about 2 × 3 cm.

The patient's local symptoms gradually improved under appropriate treatment, and successive pyelographic exposures, made at

This case represents the comparatively rare form of horseshoe or fused kidney, presenting a fusion of the upper renal poles, so that the concavity of the whole mass faces downward. The two kidneys, joined by a connecting bridge running transversely across the course of the vertebral column, were *in vivo* displaced medially and inferiorly. Both renal pelves are on the anterior surface of the renal halves and both ureters take their course over the anterior aspect of the connecting bridge in an almost straight line to the bladder, where they insert in an entirely normal fashion. *In vivo* the left renal half was found to be located considerably lower than the right, thus showing both stone shadows at about the same level on the plate.

Fig. 4 is a reproduction of an X-ray photograph of the specimen, showing both concrements *in situ*.

Statistical reports upon the frequency of horseshoe kidney are variable. Among 6200 autopsies, performed in the Pathological Institute of Berlin from 1897 to 1900, this anomaly was found in 6 instances, or in 0.1 per cent.,<sup>14</sup> while Socin<sup>15</sup> observed 5 cases among 1630 autopsies, giving a percentage of 0.3. The condition, therefore, is not so rare as not to be of more practical importance to urologist and surgeon than single or hypoplastic kidney. Quite a number of kidney operations are recorded in the literature in which unexpectedly a horseshoe kidney, with disease and infection of one renal half, was encountered. In some of the reported cases the intended operative procedure was abandoned upon recognition of the true renal condition. Some operators, like Israel,<sup>16</sup> Socin,<sup>17</sup> and Thompson, Mayo, and Harris in this country,<sup>18</sup> were successful in removing the pyonephrotic part of the horseshoe kidney, the remaining part of which was afterwards functioning satisfactorily. There are, though, also found case reports, according to which the unilaterally diseased horseshoe kidney was removed *in toto*, and where the true renal situation was only recognized by the pathologist after the patient's death. The question therefore arises: Which, if any, clinical criteria do we possess, leading towards a probable pre-operative recognition of the existence of an unilaterally diseased horseshoe kidney?

A palpable mass, presenting suggestive configuration and posture; location of radiographically ascertained renal concrement shadows either at or much closer to the spine than in the normal; bilaterally symmetrical dilatation of renal pelves or hydronephrotic conditions, due to the course of both ureters on and over the kidney; and marked cardiac symptoms brought about by pressure upon the descending aorta by the renal connecting bridge: these are the main symptoms, which, in





FIG. 4.—Skiagraph of horseshoe kidney, showing a calculus on each side.



FIG. 5.—Double bladder in a prostatic.

Englisch<sup>22</sup> describes large congenital pockets of the bladder (Blasentaschen) similar in form to the upper cavity of my case; their differentiation from diverticula (Blasenzellen) is based upon the structure of their walls, which, besides mucous membrane, may contain one or all muscular strata of the bladder proper. According to Kathelin and Sempé<sup>23</sup> the true double bladder originates from the symmetrical anlage of the allantois and produces forms like those described by Rose,<sup>24</sup> Schatz,<sup>25</sup> and Woelfler,<sup>26</sup> where both vesical cavities are entirely separated, possessing separate ureters and an internal meatus leading to a separate urethra.

I can find, however, no record of a case like mine, of a vesical pocket or diverticulum presenting such strikingly symmetrical features in size and configuration and thus at once producing the aspect of vesical duplication. The wall of the excised viscus possesses, besides that, the histological structure of the bladder-wall. For these reasons, therefore, and especially for practical purposes, my case deserves to be designated as double bladder.

CASE IV.—*Congenital diverticulum of the bladder, hypertrophy of prostate, chronic cystitis.* A man of fifty-eight came under hospital observation with severe cystitis and uroseptic symptoms. He had suffered for some time past from urinary disturbances and at times had noticed blood in his urine. His present illness had been ushered in by a severe cold. Physical examination was negative, kidneys not palpable. Prostate per rectum considerably enlarged. The patient suffered from almost constant and most distressing tenesmus resulting in continuous dribbling. Urinalysis: Very cloudy urine, containing mass of microscopic pus. Bladder capacity about 40 c.c. with 15 c.c. of residual urine, presenting the appearance of pure pus.

After long and painstaking preparatory treatment of the bladder it was only possible to obtain momentary cystoscopic glimpses which revealed a moderately trabeculated bladder wall and the fairly normal outlines of the sphincter, while inspection of trigone and fundus was frustrated by almost instantaneous clouding of the irrigating fluid.

These urinary symptoms and cystoscopic findings seemed to point as taking their origin from a renal focus, and all efforts were, therefore, concentrated towards effecting bilateral ureteral catheterization. When, after many futile attempts, this was finally performed, clear and microscopically and functionally normal urine was obtained from both kidneys, thus proving by exclusion the vesical character of the condition.

regular intervals, demonstrated a gradual increase in the diverticular sac and a widening of its communicating opening; the pyelogram finally revealed the shadow of the bladder cavity, the contour of which presented several grotesquely shaped protuberances (diverticula), and which by a broad communicating opening was separated from the apparently larger bell-shaped upper cavity (Fig. 5).

Meanwhile, the patient's general and local condition had materially improved; urine showed microscopic absence of casts, two hours' phthalein had increased to over 60 per cent., twenty-four hours' urea ranged between 25 and 30 grammes. The operative removal of the upper vesical sac was, therefore, decided upon.

*Operation.*—In gas-ether narcosis the bladder was opened suprapubically; by means of a forceps, introduced through the diverticular opening, the upper sac was grasped, and easily inverted into the bladder proper; it was then resected over a clamp and its edges were stitched by several rows of catgut sutures. Closure of bladder and suprapubic incision around rubber tube.

Dr. Ophüls' report upon the histological examination of the resected sac was as follows:

Sections show wall of fibrous tissue in which there are some strands of involuntary muscle. The inner layer is formed by more cellular and vascular connective tissue which is extremely hyperæmic and infiltrated with leucocytes. The inner surface is partly covered with stratified epithelium. In wall several small arteries with very marked endarteritis.

The post-operative course was eventful and complicated; aside from reappearance of pyelonephrotic symptoms, bronchopneumonia and a painful phlebitis set in; finally, though, after a very slow convalescence, the patient made a good recovery.

Six months after the operation, the patient urinated at regular intervals, about every four hours; urine fairly clear, the bladder contained about 60 c.c. residual urine.

The literature contains but scant references upon duplication or multiplication of the urinary bladder. Arthur Strauss<sup>20</sup> reports the case of a man of twenty-nine in whom, on suprapubic cystotomy, three separate bladder cavities were encountered, two smaller ones of the size of a pigeon egg, and a third one, lying beneath the two smaller cavities, revealing a capacity of 300 c.c. Both smaller cavities had, like the upper cavity in my case, no trigone and ureteral orifices. Gueterbock<sup>21</sup> mentions a case in which multiplication to five urinary bladders in the same individual was observed. Especially in women double bladder was often observed in connection with duplication of other organs of the urogenital tract.





FIG. 6.—Congenital diverticulum of the bladder.



MARTIN KROTOSZYNER

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- <sup>18</sup> Am. Surg. Ass'n, June, 1911.
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- <sup>20</sup> Centralbl. f. Chir., vol. xxvi, 1899.
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- <sup>22</sup> Ueber Taschen u. Zellen d. Harnblase. Wiener Klink., vol. viii, 1894.
- <sup>23</sup> La vessie double. Ann. des mal. génito-urin., 1903.
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The existence of a diverticulum, as the cause of the condition, seemed now to be obvious, but repeated collargol cystography, made at this time, proved futile as regards diagnostic results, since the injected silver salt was almost immediately expelled from the irritable bladder. Finally, a cystogram obtained after filling the viscus with oxygen demonstrated a large diverticular sac (Fig. 6).

By methodical dilatation treatment bladder capacity gradually was increased, until cystoscopic demonstration of the diverticular opening was feasible; it was found to be located at the trigone, a little below and to the left of the right ureter, and its diameter was about  $2 \times 2.5$  cm.; the depth of the sac was 5 cm., as ascertained with the tip of a ureter catheter.

The patient refused operation and left the hospital with a bladder capacity of over 150 c.c., and his local symptoms considerably improved.

The case deserves to be reported in this connection on account of its unusual diagnostic features; viewed from this angle, the observation furnishes an instructive contribution to the difficult chapter of the differential diagnosis of incipient prostatism and congenital diverticulum of the bladder.

The important lesson to be derived from the study of the small number of cases, grouped together in this communication, may be tersely expressed in the following appeal to the urologist: In every severe and etiologically obscure lesion of the urinary tract, presenting unusually difficult diagnostic features, consider the possibility of an anomaly of congenital character to be the underlying or complicating factor.

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other, they stimulate, they retard, they may stop the functions of each other.

There is no way of determining at what date an abnormal condition will interfere with the coextensive function of the afflicted organ. Consequently, the question of indication for the removal of renal concretions simmers down to the question of immediate interference or of postponing it up to a time that is deemed desirable by the surgeon for reasons of general condition. It may be a subject of discussion, whether in a given case infection and inflammation or the concretion was the primary instance; but if once a calculus is formed, then there remains no doubt that this foreign body will be a constant source of irritation, and, especially if movable and raw of surface, may lead to considerable traumatism. That concretions are apt to grow constantly by apposition is another factor to be taken in consideration.

The statement that some concretions are discovered accidentally only does not mean much, because if there would not have been any symptoms, no X-ray picture would have been taken. The urgency of the indication will be determined by the character of the symptoms. If the suffering of the patient is frequent and intense, we will attempt early relief, if movements are apt to produce attacks we will try to prevent further traumatism to the kidney, the occurrence of which is proven in an objective way by the appearance of blood in the urine; the finding of pus and of formed kidney elements in the urine will appeal to us as an incentive for early operation, because it is significant of a progressive destructive process in the kidney.

In this way a large stone on account of its being immobile may give latitude to the time of operation, while a small movable stone will call for the earliest intervention feasible.

At the present time we are in position to be rather liberal with our indications for stone operations on account of the improvement in our operative methods.

We know now that most of the concretions may be successfully removed by the opening of the renal pelvis only, thus avoiding any damage to the secreting parenchyma of the kidney; even if we have to resort to a splitting of the parenchyma the method of fat transplantation, which I am practising to great satisfaction, deprives the nephrotomy of all its terrors, among which the post-operative hemorrhage was most prominent.

I would like to dwell a little on the ureterotomy—the opening of the ureter for the removal of stones. I am convinced that in this class of cases the utmost conservatism is warranted. It is a matter of ex-

## NOTES ON INDICATIONS IN KIDNEY SURGERY.

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It seems that in no other field of kidney surgery one has to be so careful about the operative indications as in cases of floating kidney. In the first place it is known that the floating kidney in the majority of cases is only one of the conditions due to the general asthenia of the fibrous system supporting the inner organs, and it is obvious that the remedying of only a single instance will not relieve the number of symptoms due to a general enteroptosis. Nephropexy ought only be resorted to after it is ascertained that the most annoying symptoms are due to the abnormal mobility of the kidney, and that by putting the patient at rest and replacing the kidney these symptoms remain subdued. Even then this operation should only be undertaken if all other non-operative measures have failed to furnish relief; such measures are fattening up of the patient, resistance gymnastics, retaining pads. The prognosis has to be made with great caution, because, although the anchoring of the kidney should turn out to be an orthopædic success, the relief may be not a complete one. It is known that in floating kidney there may periodically occur a dilatation of the pelvis and of calices producing regular attacks known to the profession as Dittel's crises; these attacks being based on the development of a temporary hydronephrosis. It is a matter of experience that these conditions may periodically recur, although the kidney was properly fixed and remained so; it therefore seems that in these cases this dilatation of the renal pelvis and the calices is due to a temporary paresis of the pelvis produced by nervous influences and not by mechanical obstruction, as kinking of the ureter. Therefore even a durable anchoring of the kidney may not be sufficient to do away with these attacks. More strict is the indication for operative steps in cases of floating kidney due to a trauma that jolted the kidney out of its fastenings. In these cases the results are almost universally satisfactory.

In cases of calculi in the kidney it may be stated in a general way, that the discovery of a concretion in the kidney is identical with the removal of it, except if the general condition of the patient determines him to be a poor surgical risk. Among the profession the tendency is growing firmer to remedy everything that is not normal. We know that all the internal organs are in a state of interdependence on each

form a menace to the life of the patient if not operated on at a very early date. Early operation will be indicated if we have to deal with a rapidly developing process progressing so fast that the life becomes endangered either by the involvement of the other kidney or because the system is so rapidly flooded with toxins, that the resistance of the patient is quickly consumed and death occurs on account of foudroyant sepsis. As leading symptoms marking a rapid progress of the destructive process are eminent, constant rise of temperature, repeated chills and the appearance of blood with the pus in the urine.

The constant rising of the temperature is due to the increase of toxins in the circulation; each chill marks the establishment of a new inflammatory focus, and the appearance of blood is significant for the progress of destruction. The item hemorrhage deserves a little discussion. It will happen that after the initial stage of the attack the blood will disappear out of the urine, but that does not mean that the hemorrhage into the kidney has stopped. The fallacy of such an assumption may be very easily proven. If in such a case the observer places his hand on the kidney region, exerting slight pressure, the blood will reappear in the urine and cystoscopic observation will demonstrate the emanation of liquid blood out of the pertaining ureter, as a rule preceded by a worm-shaped coagulum. The explanation of these phenomena is this: Constant and copious hemorrhage inside of the kidney will overdilend the renal pelvis, the ureter not being spacious enough to carry off the blood as quickly as it is effused, and an occasional coagulation inside of the ureter may add another mechanical obstacle. In this way the tension in the renal pelvis is increased to such an extent that its expelling power is annihilated, paresis of its walls setting in. The apparent cessation of the hemorrhage under such circumstances becomes another danger signal.

We know that if infectious exudates are under pressure and tension the danger of general sepsis is increased, therefore, if during an acute attack a kidney becomes distinctly palpable, although not being considerably enlarged, the proof is furnished that the contents are under high tension, and immediate relief is indicated.

The findings after having exposed such a kidney are rather impressive: The whole perirenal tissue is oedematous, the surface of the kidney is punctured by innumerable subcapsular hemorrhages, the pelvis presents itself as a livid sac, the ureter is distended to the utmost.

While these rather stormy kidney infections, discussed above, are due to the activity of colon bacilli or staphylococci, the invasion of a kidney by streptococci produces an entirely different clinical picture.

perience that most of the ureteral concretions eventually pass spontaneously into the bladder ; it is an established fact that in the majority of instances a ureteral concretion may be brought down into the bladder by the simple expedient of introducing a ureteral catheter into the ureter, pushing the catheter up to the stone, and by injecting some lubricant.

At the same time it must be kept in mind that the exposing of the abdominal part of the ureter is always an operation of great dignity ; it is a not infrequent sequela of this operation that the exposure of this organ leads to formation of adhesions and of fibrous tissue around the injured part, which in turn may kink or compress the ureter to such an extent that the pertaining kidney is put out of activity. To this has to be added that the exact diagnosis of a ureteral stone quite often will meet with serious obstacles. Even the employment of the shadowgraph catheter, introduced by me in our diagnostic armamentarium, does not always protect one from errors. I repeatedly saw very competent surgeons perform a very lengthy operation without being able to find the supposed stone. The ureterotomy therefore has to be restricted to the most cogent indications, as which have to be quoted persistent reflexoric anuria or signs of urinary sepsis. If a ureteral stone becomes impacted inside of the vesical end of the ureter an attempt may be made in females to massage it out of the ureteral end into the bladder by bimanual manipulation. If that turns out to be a failure the ureteral mouth is split and the concretion extracted either by means of endovesical intervention (operative cystoscope) or after the interior of the bladder has been exposed by suprapubic cystotomy.

Bacterial invasion of the kidney will become an object of surgical attention as soon as an inflammatory involvement of the parenchyma is recognized. There may be an argument as to the time of operation and as to the extent of the intervention, but it must be asserted that only in the minority of cases a so-called spontaneous cure will occur. Even if that should be the case, it must be taken into consideration, that this thickening of the exudate and the final obliteration of the focus by calcification or by fibrous sclerosis is only obtained by the more or less extensive loss of the renal parenchyma, while a timely operation may have helped in confining this destruction to narrow limits. Some observers claim that it is best to tide the patient over the time of the acute attack and to operate during the cold period, giving the local and general immunization a chance to fortify the system. While this contention is still a matter of diversified opinions, it remains a fact that certain kinds of renal infections are of such a character as to

intrarenal pressure, although the pressure in the general vascular system may be abnormally increased. If now an excessive sudden rise in the blood-pressure occurs, there will be a danger that these safeguards may be overcome so that the intrarenal pressure will reach a degree apt to damage the secreting epithelia. The manifestation of such sudden vacillations may be regarded as forming an indication for operative interference in cases of nephritis.

Whether there exists an excessive intrarenal pressure can only be determined while the kidney is *in situ*, because any artificial dislocation of this organ will produce a secondary hyperæmia due to the stretching or twisting of the pedicle. Therefore after having exposed part of the surface of the kidney in question a little slit is made into the fibrous capsule, while the kidney is still *in situ*; if the parenchyma protrudes through this little incision then one is justified to assume a hypertension inside of the kidney and to expect some benefit from the decompression after Edebohls.

Metastatic suppurations in the fatty capsule of the kidney are quite often entirely overlooked or their symptoms are misinterpreted. This is regrettable, because an early diagnosis not only will serve to save the patient a great deal of suffering but timely interference is also important on account of the extensive destruction that after a while will result and on account of the danger of general sepsis, always present in suppurations in fatty tissue. It must be kept in mind that suppurations in the fatty capsule may become established independently from suppurations in the kidney, because the adipose capsule possesses arteries of its own able to import hæmatogenous infection. That accounts for the fact that adipose inflammation may be present, although the urine does not contain any products of infection. All these suppurations are accompanied by a rather high fever of an intermittent character, chills are not uncommon, pain in the kidney region is always present and very often the diuresis is considerably increased.

Special syndromes are dependent upon the localization of the infection and inflammation. In case the inflammatory exudate distends the fatty capsule at the posterior circumference of the kidney the pain and sensitiveness is very pronounced in the flank. If inflammatory infiltration occurs around the lower pole, then on account of the peritoneal irritation intestinal symptoms will appear in combination with exquisite sensitiveness around the lower pole.

Deep inspiration produces pain and paroxysms of coughing may be excited by involvement of the diaphragmatic pleura in case the inflammation extends upward. Pressure around the lower pole of the kidney

These streptococcus infections, however, are of such an importance as to render them worthy of some discussion.

Colon bacilli and staphylococci manifest their occupation of renal territory by the ample production of pus, and, if hemorrhage occurs at all, it is rather profuse.

The streptococcus infection of the kidney leads to hard infiltration of the renal parenchyma, and the production of pus is negligible, the hemorrhage of an occult character.

The presence of such an infection announces itself by the appearance of œdemas in various parts of the bodily surface, appearing in one place, then disappearing there and establishing themselves in some other location; in the early stages such œdemas will also occur in the muscles of the eye and in the background, leading to minor disturbances in the sight. The urine contains albumen, almost no pus cells, but early hyaline and granular casts appear; the effusion of blood into the renal parenchyma, though red blood-corpuscles may be very scant or entirely absent, is revealed by the appearance of large round cells, stained yellow by the products of the breaking up of red cells.

The diagnosis of the streptococcus infection of the kidney is very important, because if no surgical aid is furnished, the patients invariably become blind in the further course and finally succumb. The oculists assert that the ocular changes in such cases may be differentiated with certainty up to the final period from the classic symptoms of albuminuric retinitis due to non-bacterial parenchymatous nephritis. Therefore, if fleeting œdemas occur, if the urine contains albumen, hyaline or granular casts and signs of occult hemorrhage, bacterial investigation of the kidneys with all the modern aid has to be undertaken forthwith. The establishing of the diagnosis of streptococcus nephritis calls for immediate surgical interference, nephrotomy or nephrectomy according to the qualification of the findings.

Operation in cases not too far advanced almost invariably will lead at least to a symptomatic cure, failure to furnish surgical relief means condemning the patient to blindness and eventual death.

Although personally I am able to report only temporary successes with the Edebohls operations, in cases of parenchymatous and interstitial nephritis, there are quite a few authors who assert to have achieved permanent results in some of their cases of this kind. There seems to be a theoretical possibility for qualifying the indications in such instances and to formulate the prognosis by midoperative observation.

The kidney is provided with certain safeguards to maintain an even



# BILATERAL POLYCYSTIC KIDNEY

A CASE TREATED BY PUNCTURE OF THE CYSTS

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THE following report of polycystic kidneys presents some features of interest: First, size of the kidneys; second, the hæmaturia; third, bilateral renal infection; fourth, result following puncture of cysts; fifth, death of patient's sister from renal insufficiency from double polycystic kidney.

Patient, a female, aged fifty-seven, was referred to me by Dr. E. Y. Davidson, of Washington. She had never been robust, but led an active life, earning her own living. Five years ago a hysterectomy was performed for some condition not ascertainable.

Dr. Davidson has seen her on several occasions for minor ailments, but never made a thorough examination until called in on March 10, 1915, because of patient being quite ill and passing bloody urine. A tumor was detected in left side and right side of abdomen.

Patient was seen by me, March 11, presenting the following conditions: She was anæmic, somnolent and appeared ill, running a temperature from 97° to 101°. The urine was very bloody, containing large clots. On abdominal examination a large mass was felt on the left side, extending above ribs and below a line drawn from one anterior superior spine to the other. The mass was nodular, the nodules varying in consistency and fluctuation being distinctly made out in some portions.

The whole mass was movable, although the patient complained of pain during this procedure. On the right side the same condition was present, extending lower down toward the pelvis, but the circumference was less than on left—on inspection the right side of abdomen was smaller than left.

On vaginal examination, a mass could be felt on right side fluctuant and movable; this suggested a cystic ovary.

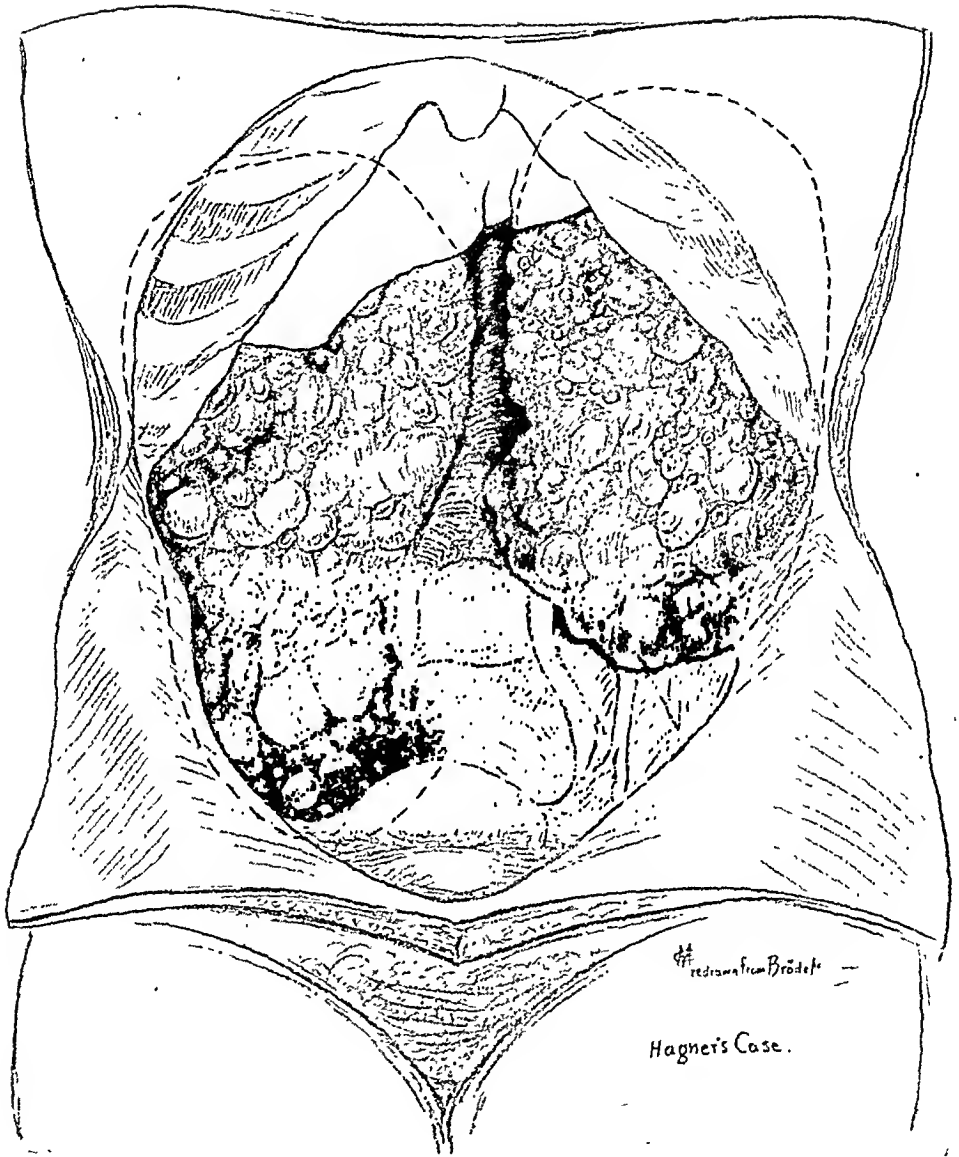
Patient was cystoscoped and both ureters catheterized. Bladder showed evidence of chronic inflammation. Urine obtained from right side showed many pus cells and hyaline casts; a clot was present in left ureteral orifice, but the catheter was easily

## INDICATIONS IN KIDNEY SURGERY

evokes reflectoric contraction of the abdominal muscles. If the abscess or the abscesses are located around the anterior surface of the kidney then the clinical picture may be obscured by vomiting due to compression of the ductus choledochus or the vertical part of the duodenum.

Any time that in presence of some known suppurative focus sudden pain in the kidney region is observed, combined with high fever, metastatic suppurations in the fatty capsule have to be thought of, especially if the diuresis is increased and if the otherwise normal urine contains pathogenic bacteria. That adipose inflammation may be present, although the urine does not contain any products of infection, is accounted for by the fact that pathogenic germs may be filtered through the kidney without exciting any inflammation in this organ, although producing inflammations in other structures into which they have been carried by the blood stream.





Redrawn from Brödel's

Hagner's Case.

FIG. 1.—Bilateral polycystic degeneration of kidneys.

## FRANCIS R. HAGNER

Body of white woman. Poorly nourished. External examination negative except for operative wounds. Chest negative. Heart slightly enlarged. Valves competent, slightly thickened.

Abdomen: Liver and gall-bladder negative.

Stomach negative. Intestines negative. Pancreas negative. Spleen negative. Both kidneys very much enlarged and polycystic. A number of the cysts had been punctured at operation. Only a few small areas of kidney structures were evident on section. The entire mass otherwise being made up of cysts containing pus, blood, or gelatinous material.

I have seen some of the work of Dr. Fred Lund, of Boston, along the line for which this patient was treated. Some of his cases after puncture of the cysts have been very much improved and several of his cases are alive two to three years after this operation. The cases, however, that I have seen him operate on have never been as extensive as this one.

This disease affects women more frequently than men. In Seiber's tables, in 198 collected cases there were 116 females and 82 males. Polycystic kidney is a rare disease. Preitz, on examining the records of the Keil Institute, found among 10,000 autopsies only 16 cases of polycystic kidney. In the Boston City Hospital in the records of 2,429 autopsies, occurring during the last ten years, there were ten cases.

The cysts are closely packed together and invade every portion of the kidney. The walls of the cysts are usually very thin, and inside of them are sometimes seen the remains of septa which mark the places of coalescence of neighboring cysts. The fluid varies in color as described in this case.

The kidney substance between the cysts is compressed and is fibrous and hyaline in character. Cysts of the liver have been associated with this condition of the kidney.

The pathogenesis of polycystic kidney is involved in great obscurity. It would appear that the disease in the adult and the infant is the same, yet it is hard to explain why the disease is not found between infancy and twenty-one years of age. The cysts in the adult appear to develop in large part in the convoluted tubules; this appears to be the case from the fact that in the slighter forms of the affection most of the cysts are found in the cortex.

The following theories have been evolved to explain the pathogenesis of polycystic kidney in the adult: First, the theory that the process is new growth; second, that the process is a result of inflammation and sclerosis of the interstitial tissue between the tubules; third, that the process is due to malformation and consequently must be congenital; and fourth, there are some who combine these theories and who

## BILATERAL POLYCYSTIC KIDNEY

passed up 20 cm. into ureter—no fluid passed through catheter but washings of the catheter after its removal showed clots and clumps of pus cells. Culture from urine obtained from ureter showed colon infection. X-ray negative for calculi. Urine showed .55 per cent. of urea—8.08 grains in twenty-four hours. Phthalein tests showed 3 per cent. in seventy minutes.

Blood-pressure: diastolic, 130, and systolic, 190. A diagnosis of double polycystic kidney was made.

March 15, patient was operated on, under nitrous oxide and novocaine anæsthesia. An extraperitoneal operation was performed; an enormous polycystic kidney was exposed that measured 11 inches from pole to pole. The kidney was a mass of large and small cysts containing fluid of varying consistency, colored blue, green, yellow, pink and various hues of these colors. After puncture of the cysts the kidney shrank to nearly one-half its original size.

Cultures at time of operation from various colored cysts remained sterile. Patient made a good recovery from this operation.

On March 19, patient voided 990 c.c. urine; urea, 1.2 per cent.; urea retention was 3.6 grammes, phthalein test showed 14 per cent. the first hour and 14 per cent. the second hour as compared with 3 per cent. before operation. The right kidney was operated March 23, the same condition being found as on the opposite side, except that the kidney was much larger, extending from 2 inches above the ribs to floor of the true pelvis. This kidney measured 14 inches.

Several ureteral catheterizations were made and the pelvis irrigated; blood disappeared shortly after the first operation; slight recurrence was noted for a few days but stopped spontaneously.

The urea output varied from 9 to 15 grammes in twenty-four hours since the second operation, and the amount of urine from 1500 to 2000 c.c. Specific gravity, 1012 to 1015; the phthalein output has not been higher than 14 per cent. first hour and 16 per cent. second hour.

From March 15, the time of the first operation, all the symptoms of the patient improved. This continued until about May 1, when she began to fail, death occurring on June 2. The patient lived about two and one-half months after the first operation. I cannot help but feel that the puncture of the cyst prolonged her life. It is really remarkable how these patients can live at all with the small amount of kidney structure that they appear to have, and I think this will be seen when the kidneys are examined.

The autopsy was performed by Dr. Lindsay and is as follows:

Dr. Barnett, of Fort Wayne, Indiana, a few years ago, collected a series of polycystic kidneys. He was especially interested in, and believed in, a unilateral disease in some cases. There were quite a number of men reported cases of unilateral disease, but among those that reported unilateral cases were invariably those that had had one or possibly two cases—the men with a larger number of cases, such as the Mayos, reported 20 cases, all bilateral. This is true also of the clinics at the Hopkins and at the New York Hospitals. Two of my friends who had reported cases on which they had done a nephrectomy for supposedly unilateral polycystic kidney, afterwards found that the patients had bilateral disease, so I feel that we can safely say that all cases of polycystic kidney are bilateral, and from results with Dr. Lund's cases, I think the only surgical operation we are justified in doing is puncture of the cysts.

would explain the origin of polycystic kidney as the result of both malformation causes and subsequent tumor formation.

Malassez first conceived the theory of new growth, but Brigidi and Severi believed that the cyst contents were nothing more than the protoplasm of the epithelial cells fused together. They thought that they could observe nuclear division of the cells. They also thought that they could see young elements in the tubules and in the smaller cyst cavities. They compared the affection to ovarian cystoma. Ritchie was of the opinion that the process was one of new growth, but he thought that the disease in child and adult entirely distinct, believing that the adult cystic kidney is to be classed with the adenomata, while the congenital variety should be considered an error in development. Virchow believed that the cysts were true retention cysts and that they resulted from occlusion of the urinary tubules in consequence of inflammation of the interstitial tissue in the papillæ of the kidney. This view has been entirely abandoned, this inflammation being seldom found in infancy and is almost never seen in adults. The interstitial inflammation is now regarded as a sequence of the disease and not a cause.

The theory that the disease is in all cases congenital, and is in the nature of a malformation, has many adherents. The fact that it occurs so often in members of the same family suggests some intra-uterine influence.

If we examine into the embryology of the kidney we shall see that there is good reason for supposing that malformation causes may be in part at least the origin of the condition. Huber has definitely shown that the fully developed tubule, that is, from its beginning in the glomerulus to its exit in the renal pelvis, is in the first instance formed from two separate structures. In early embryonic life there is formed a renal vesicle and a primary collecting tubule. The vesicle is situated at the outer side of the tubule. Later union takes place between two structures with the formation of a single canal. It is easy to see that if union failed to occur a cystic condition might result in the tubule which did not have an outlet.

The most plausible explanation seems to be that the disease may originate in consequence of embryonic malformation and that subsequent neoplastic formation takes place. The interstitial changes of the compression caused by the cysts themselves still further tend to augment the size of the cysts.

I wish particularly to bring out the fact that probably all polycystic kidneys are bilateral.



tissue is always left. The only treatment considered is marsupialization, except in especially favorable cases which permit of a partial resection of the kidney followed by suture. He treated one case in this way, thereby shortening the convalescence.

While echinococcus cyst of the kidney may appear at almost any age, the youngest and the oldest patients that we have been able to find were three years and seventy-four years respectively. It is probably more frequent during middle life. It is more prevalent in females than in males and is said to attack the left kidney more frequently than the right. There is a wide variation among authors in the frequency in which echinococcus disease occurs in the kidney. Haynes states that it is 3.7 per cent. and that it is usually associated with echinococcus disease of other organs (*ANNALS OF SURGERY*, xxxvi, 1902). Vegas, H., Cranwell, D., state that in 920 cases of echinococcus disease, it occurred 20 times in the kidney, 2.1 per cent. (*Ctrbltt. f. Chir.*, No. 3, 1904). Prat reports that in 471 cases of echinococcus disease, it occurred twice in the kidney, .42 per cent. (*Revista d. l. Hospitale*, Tome vi, No. 8, 1913). Ribera states that in 117 cases of echinococcus disease, it occurred 7 times in the kidney, 5.9 per cent.

The cyst may invade the whole kidney leaving no parenchyma, as in our case, or it may involve only a portion of the kidney, one pole or the other, or it may grow in the pararenal tissue only, compressing the kidney; furthermore, the cyst may or may not open into the kidney pelvis. The cyst is usually very adherent to the surrounding organs and the wall may be the seat of calcareous deposits. Upon its location, duration, size and involvement, the operative procedure necessarily depends. Echinococcus cyst has been reported in nearly all the different kidney conditions. Eberle and Celowski independently found it associated with floating kidney; Monad and Lane, independently, in hydronephrosis. Houzel did a nephrectomy for echinococcus cyst in a solitary kidney; proved by autopsy. Juvara did a nephrectomy for hydatid of a left ectopic kidney. It has been associated with hydatid of the liver and other organs. Parlavecchio and Nicholich each report a case of hydatid cyst of the kidney rupturing into the bronchi and intestine with the discharge of daughter cysts through these ways as well as through the urethra. Hydatid cyst of the kidney is a slow-growing tumor extending over years and may present a varied degree of symptoms or none. From symptomless tumors accidentally discovered in the course of examination, the picture changes through the varied stages of pain and discomfort in the lumbar region to the severe

# A CONTRIBUTION TO ECHINOCOCCUS DISEASE OF THE KIDNEY

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IN reviewing the literature of echinococcus disease of the kidney and adding one case thereto, it is not our intention, nor is it within the scope of this paper, to discuss the zoological distribution, the life cycle, etc., of this very interesting little tapeworm (*Tania echinococcus*).

With the exception of Nicaise's two very valuable contributions, namely, *Thèse de Paris*, 1904-1905, *Archives générales de Chirurgie*, iii, 1909, p. 453, the literature is very fragmentary and, for the most part, from those countries in which echinococcus disease is much more frequent than in ours. The contributions from the North American hemisphere have been very few indeed, and, for this reason, we have deemed it wise to call attention to the possible existence of this disease in the diagnosis of those unusual and obscure conditions met with from time to time in the region of the kidneys. Nicaise (*Archives générales de Chirurgie*, iii, 1909) collected 402 cases, but neither tabulates nor lists them by reference. Hence, we have tabulated and referenced, so far as possible, these cases, 43 in number, appearing in the literature since Nicaise, *Thèse de Paris*, 1904-1905, in which he has given a most extensive bibliography. Of the 402 cases collected by him, 216 were treated surgically, 169 of which were treated by drainage, enucleation of the cyst or partial nephrectomy, with a mortality of 7.1 per cent. In the second group of 42 cases treated by nephrectomy, there was a mortality of 19 per cent. He advises the employment of the more conservative method and cautions against nephrectomy, since it is productive of so great a mortality. Kümmell, H., and Graff, H. (*Handbuch de praktischen Chirurgie*, vol. iv, 1914), state that echinococcus cyst of the kidney is rare and that there are 36 cases in which operations have been performed, which statement we interpret to apply to the German Rhenish provinces. He believes the cysts never to be multiple, and that, in spite of the compression of the cyst, some renal

suppuration with the possibility of rupture and a fatal outcome. Enucleation of the cyst or partial nephrectomy, the method of choice, is applicable only in certain cases. Marsupialization and incision and drainage have the disadvantage of slow healing and the danger of secondary pyogenic infection. Bonamy (*Paris Chirurgical*, ii, 1910) cites a case in which he marsupialized the sac and in which carcinoma developed two years later, the patient dying from hemorrhage. On the other hand, either one is a short, quick operation and attended with a low mortality. Nephrectomy may be a very difficult operation, as it was in our case. The cyst is usually very adherent to the surrounding tissue, especially anteriorly to the peritoneum and the intestines. The peritoneum is so closely adherent that it is difficult to deliver the kidney and cyst into the wound without entering the peritoneal cavity and there is the added danger of causing injury to the intestines. It has the great advantage of a short convalescence and is much preferable to drainage in properly selected cases. Briefly, whether we shall do an enucleation, a partial nephrectomy, a marsupialization, a drainage or a nephrectomy, depends upon the conditions encountered at the time of operation. Should post-operative hydatid intoxication supervene, Prat advises the administration of adrenalin chloride 1:1000, which he found to neutralize toxic doses administered to dogs.

HISTORY OF CASE.—M. R. (Case History B. 8544), Italian male, aged forty-six years. Entered The Roosevelt Hospital October 20, 1916. Discharged December 16, 1916, with the following brief history. He is married, has two children living and well. Has had no previous acute illness, does not use alcohol, smokes very moderately, two or three pipes a day. Denies venereal infection. Six months ago he had an attack similar to the one for which he entered the hospital. Eight days before coming to the hospital, he had a chill and fever followed by pain and burning in the right kidney region. There was no nausea or vomiting and no urinary symptoms other than he thought the urine a little darker during the attack but had noticed no blood. Upon further questioning him after operation, we elicited the fact that he had observed small grape-like cysts in his urine from which he could squeeze watery contents. Had we obtained this statement before operation, a correct diagnosis should have been made. The physical examination elicited slight tenderness over the right kidney; no mass could be felt. His fever reached 101° upon the first two evenings and then remained normal until after operation. White blood-cells, 9400; polymorphonuclears, 72 per

cases of renal colic, associated with hæmaturia or not, and with the expulsion or not of daughter cysts in the urine. These symptoms recur in attacks of greater or less severity from time to time. In those cases in which the cyst has opened into the renal pelvis with the expulsion of cysts or hooklets in the urine, the diagnosis is self-evident. On the other hand, when these symptoms are lacking, it is rarely possible to arrive at a correct diagnosis. The Weinberg complement-fixation test (*Annales d. l'Institut Pasteur*, No. 6, 1909) being positive, an associated eosinophilia with the presence of a tumor in the kidney region would point strongly to echinococcus disease of this organ; on the other hand, with a negative urine, cystoscopic and ureteral examination, with no palpable tumor, the eosinophilia and the positive Weinberg complement-fixation test (which is said to be present in two-thirds of the cases) is but of little assistance in localizing the hydatid even if it be present.

Welsh, Chapman and Storey (*Transactions Australian Med. Congress*, 1909) believe the negative results in the precipitin reaction are inconclusive; that positive results are conclusive of hydatid invasion and are of very considerable clinical value; aspiration is cautioned against as a diagnostic procedure, since it is not infrequently followed by hydatid intoxication and incurs a danger of inoculation to other tissues, etc. The condition has been mistaken for ovarian cyst, appendicitis, pregnancy, floating kidney, hydronephrosis, pyonephrosis, etc. The cyst, not infrequently, undergoes pyogenic infection with the added symptoms of this condition. The disease is a surgical one and the ultimate result is necessarily prognosticated by the patient's condition, the extent of invasion, the surgical procedure pursued and the occurrence or not of post-operative hydatid intoxication.

F. Dévé (*Revue d. Chir.*, Tome xliii, Nos. 5, 6, 7) deals fully with hydatid intoxication both from the medical aspect and from the post-operative point of view. Briefly, he divides surgical post-operative hydatid intoxication into three classes: First, *benign*—hydatid fever, urticaria, etc.; second, *grave*—fever, urticaria, collapse, syncope, etc.; third, *fatal*—high and rapid rise of temperature, collapse, embarrassed respiration with nervous manifestations and death.

Aspiration or puncture is an unwise procedure for obvious reasons, besides, hydatid intoxication being more frequent after it than in other surgical procedures, there is danger of transplanting the parasite into neighboring tissues and causing the cyst to undergo suppuration from an added pyogenic infection. Intravenous injection of salvarsan has met with but little success and it is apt to cause the cyst to undergo

was recognizable microscopically. The whole kidney was occupied by a large echinococcus cyst with daughter cysts. The cyst communicated with the pelvis.

ABSTRACTS OF CASES REPORTED IN LITERATURE

MACKEY: Tumor of left kidney. Renal colic with expulsion of hydatids through urethra. Treated with turpentine. Improved. (*Lancet*, vol. xi, 1905, p. 601.)

SOREL, R.: Enucleation of a large hydatid from the kidney. A woman of thirty years. Kidney tissue closed without drainage. (*Archiv. Provinc. de Chir.*, xv, No. 6, 1906, p. 371.)

CATHELIN, F.: Suppurating hydatid of left kidney in a woman twenty-three years old. Nephrectomy and drainage. (*Bull. de la Anat. de Paris*, Tome 81, 1906, p. 550.)

SABRAZES and MURATET: Hydatid of left kidney in a man thirty years old. Operation. (*Gaz. Hebd. Sciences Med. de Bordeaux*, lxxvii, 1906, p. 277.)

BARADULIN: Tumor right kidney in a man forty-five years old. Renal colic with expulsion of hydatid cysts in urine. Drainage. The author had found altogether in the literature, 142 cases of echinococcus cyst of the kidney. (*Ctrbltt. f. Chir.*, vol. xxxiii, 1906, p. 543, No. 19; *Monatschrft. fur Urologie*, lx, 1906.)

SANDVOSS: Of four cases of echinococcus observed by him, one concerned the kidney. (*Inaugural Dissertation*, Marburg, 1907.)

KAPSAMMER: Showed echinococcus sac and ureter at German Urological Society. (*Dtsch. Med. Wchschrft.*, 33, No. 43, 1907, p. 1802.)

GONZALEZ BRAVO: Tumor right kidney in a man twenty-seven years old. Renal colic with expulsion of hydatids through urethra. Nephrectomy. (*Revista Ibero. Americ. de Ciencias Med.*, No. 35, 1907, p. 18.)

DELANGLADE: Hydatid of kidney associated with hæmaturia and hydatids in urine. Incision and drainage. (*Soc. de Chir. de Marseille*, November, 1907; *Revue de Chir.*, 37, 1908, vol. iii.)

J. RIBERA Y. SANS: The author reports 117 cases of echinococcus cyst from Spain, including 7 cases of the kidney. Two operated upon by marsupialization; one operated upon by nephrectomy. (*El Siglo Medico*, May, 1908, No. 2840, p. 307; *Revista d. Med. Y. Chirug. Pract. d. Madrid*, 1908, p. 1029.)

PARLAVECCHIO: Large paranephritic cyst in a woman fifty years old, who, some years previously, had undergone spontaneous rupture into the bronchi and rectum. At operation, large cysts were also found in the abdomen which healed after incomplete evacuation. (*Ctrbltt. f. Chir.*, 36, No. 49, 1909, p. 1702.)

RONTIER: Large hydatid of kidney in a woman twenty-eight years old. Transperitoneal extirpation of cyst wall. (*Bull. et Mém. Soc. de Chir. de Paris*, xxxv, 1909, p. 581.)

NEGRETE, C.: Reports a case cured by marsupialization. (*Revista Ibero Americ de Ciencias Med.*, Tome xxi, Madrid, 1909.)

WELSH, D. A.: Female, aged twelve. Multiple cysts of kidney.

CHAPMAN, H. G.: Male, aged twenty-six. Multiple cysts of kidney.

STOREY, J. C.: A negative reaction of the precipitin test is inconclusive, a positive reaction is conclusive of echinococcus invasion. (*Transactions Australian Med. Congress*, 1909, p. 385.)

cent.; large lymphocytes, 12 per cent.; small lymphocytes, 11 per cent.; eosinophilia, 4 per cent.; basophiles, 1 per cent. The X-ray findings were negative. The urine was normal except for a few pus-cells.

*Cystoscopic Examination.*—The bladder urine very turbid, the last portion by catheter being thick pus. Bladder mucosa markedly congested. Bladder tolerance very poor, the bladder holding only a small quantity of fluid, about 4 oz., and even this small amount caused intense straining and desire to urinate. Catheter passes to the left pelvis very easily. Flow of urine began immediately; normal as to rate and character of flow and clear in gross appearance. Catheter passes to right pelvis very readily. No flow of urine observed. Several catheters used, all with the same result. Fluid injected into the right pelvis to start the flow came back very turbid but nothing else was obtained. The urine from the left kidney practically normal. The fluid from the right kidney contains large number of pus-cells. Further examination to confirm finding on the right side advised (October 23, 1913).

Findings exactly the same as on previous examination. No flow obtained from the right side except the return of the small amount of fluid injected to start siphonage. The pus in the urine, the congested bladder mucosa, the intolerant bladder suggest the presence of an infected kidney on the right side. Kidney probably entirely destroyed. Left kidney performing entire renal function.

*Operation* (October 28, 1916).—By James I. Russell. Right nephrectomy through an oblique lumbar incision. The kidney, situated very high, was the seat of a large semifluctuating tumor with apparently very little, if any, kidney tissue left. It was quite adherent posteriorly and densely so anteriorly, the peritoneum could not be stripped from it without entering the peritoneal cavity. After freeing it anteriorly, without injury to the intestine, the mass could not be delivered into the wound. An attempt to empty it through a suction cannula failed, due to the thickness of the contents of the cyst. It was necessary to divide the twelfth rib to deliver the kidney into the wound; in doing which the pleura was accidentally opened. The ureter, which was tremendously enlarged and thickened to the size of my thumb, was freed as far as possible and divided, cauterized and ligated; the usual closure and drainage was established. He made a smooth and uninterrupted recovery, but now has a small hernia in the lower and anterior portion of his wound.

Upon removal, the kidney, much enlarged, measured 16 cm. by 13. About three inches of ureter, which is about 6 cm. in circumference, and very much thickened, was removed with the kidney. The kidney tissue had entirely disappeared and none

## RUSSELL AND KILBANE

LONGO, L.: Large tumor of right kidney, girl of seven years. Marsupialization. (*Il Policlinico Sez. Clin.*, xxi, 1914, p. 176.)

HALAHAN, R. E.: Tumor of right kidney in woman twenty-three years old. Excision of cyst and suture of kidney. Drained. (*Lancet*, 1914, vol. xi, p. 1146.)

CARTA, MULAS, L.: Expulsion of hydatid membrane and daughter cysts in urine. Refused operation. (*Gaz. d. Orp.*, xxxv, 1915, p. 613.)

DOWNES, W.: Hydatid of left kidney. Male forty-nine years old. Nephrectomy. (*ANNALS OF SURGERY*, lxii, 1915, p. 628.)

## ECHINOCOCCUS DISEASE

BONAMY, R.: Large tumor left kidney region, pain, fever, pus in urine, in a man forty-one years old. Marsupialization of sac followed by cancerous degeneration, hemorrhages and death. (*Paris Chir.*, II, 1910, p. 100.)

PFIEHL: Left renal swelling in a man thirty-eight years old, associated with colic and retention which subsided with passing urine and hydatids. Drainage. (*Archiv. de. Med. Navale*, vol. xviii, 1910, p. 442.)

VERDELET, L.: Pararenal cyst in a girl of eight years, leaving kidney free, sac curetted and drained. (*Jrl. de Med. de Bordeaux*, 39, 1909, p. 7.)

EBERLE, A.: Tumor of right floating kidney in a woman of thirty-five years. Nephrotomy and drainage. (*Ctrbltt. f. Chir.*, vol. xxxviii, No. 50, 1911, p. 1656.)

GARRE: Large tumor of right kidney in a woman twenty-four years old. Discovered accidentally, having given no symptoms. Nephrectomy. (*Dtsch. med. Wchschrft.*, xxxvii, 1911, p. 2057.)

MINETT, E. P.: Reported post-mortem, hydatid cyst of right kidney. (*Journal Tropical Med. & Hygiene*, April, 1911.)

DE SARTO: Pain in right lumbar region in a soldier, retention of urine which subsided with the expulsion of daughter cysts through the urethra. No operation. (*Giornale di Med. Milit.*, lx, 1912, p. 6.)

GABSZEWICZ: Tumor in left kidney in a woman. Renal colic and fever. Nephrotomy. (*Ctrbltt f. Chir.*, vol. xxxix, No. 16, 1912, p. 549.)

LOUMEAN, SABRAZÈS, MARTET: Left-sided renal colic in a boy of eleven years. Expulsion of hydatids through the urethra. Nephrectomy. (*Journal d'Urologie*, Tome xi, 1912, p. 105.)

BRÖSE: Tumor of left kidney in a woman sixty-five years old. Nephrectomy. (*Ztschrft f. Geb. u. Gyn.*, 70, 1912, p. 296.)

LOUMEAN, E.: Left-sided renal colic in a man. Expulsion of hydatids through urethra. Enucleation of cyst with partial nephrectomy. (*Gaz. Hebdom. d. Sciences Med. de Bordeaux*, xxxiii, No. 4, 1912, p. 38.)

NICOLICH: Right-sided tumor in kidney region for twenty years in a woman. Five years ago serious lung affection, coughed up large number of hydatids. Hydatids in urine and in the stools. Drainage. (*Jrl. d'Urologie*, xi, 1912, p. 842.)

EDMUNDS, A.: Large tumor left kidney, woman thirty years old. Nephrectomy. (*Medical Press and Circular*, 95, 1913, p. 444.)

PLUYETTE, GAMEL: Tumor left kidney in a woman twenty-five years old. Nephrectomy. (*Arch. Provinc. de Chir.*, xxii, No. 3, 1913, p. 167.)

YEACI, E.: Tumor right kidney. Incision. Escape of hydatids. Drainage. (*Il Policlinico Sez. Prat.*, xx, No. 21, 1913, p. 743.)

JUVARA, E.: Left-sided tumor below umbilicus, misplaced kidney, Nephrectomy. (*Bull. et Mem. d. l. Soc. de Chir. de Paris*, xxxix, No. 3, 1913, p. 103.)

CUDARD: Tumor right kidney. Hydatids in urine. Marsupialization. (*Arch. de Med. et Pharm. Nav.*, Tome 100, 1913, p. 216.)

KRULL, J.: Right-sided renal colic, hæmaturia, expulsion of hydatids through urethra. No operation. (*Nederl. Tydschrift v. Geneeskunde*, lvii, 1913, p. 1950.)

DIAMANTIS: Left hydatid kidney. Male fifty-two years old. Hæmaturia, colic with expulsion of hydatids in urine. Drainage. (*Journal d'Urologie*, Tome iii, No. 2, 1913.)

PRAT, D.: Review of Hospital statistics of Uruguay, 1908 to 1912. Two cases of hydatid of kidney. (*Revista de los Hospitales*, Tome vi, No. 8, 1913.)



Preliminary drainage by means of the ureteral catheter as a preparatory measure may be very effectively employed in unilateral infected hydronephrosis, occurring from one cause or another. The individual may be depleted from disturbance of rest on account of renal discomfort and absorption, and the other kidney comparatively good, but showing a toxic nephritis. In such cases, draining the hydronephrosis, either intermittently or by the retained ureteral catheter, will improve the patient's general condition surprisingly, relieve the other kidney of its strain, and allow its function to become restored to normal. Such individuals could be operated on, and usually are, without such preliminary drainage, but their convalescence and their whole course is decidedly better when they are preliminarily prepared. Another type of disease in which preliminary catheter drainage is very efficacious is acute unilateral pyonephrosis, due either to sudden blockings with mucus, pus, calculus, or otherwise, in individuals who are acutely sick and extremely toxic. Such processes we see frequently in diabetics and tabetics, where major surgery at best is often grave, and certainly under such circumstances, I have seen such patients who were extremely sick, very toxic, with large masses in the kidney region, running high fever, where the balance could be easily toppled, who were almost immediately relieved of their absorption by an indwelling ureteral catheter, and were soon ushered into such condition as to make surgical attack safe. It is really surprising, and indeed almost unbelievable what wonderful effect ureteral catheter drainage will have on these extremely toxic individuals. In practically all of them the other kidney improves in function, and the diseased kidney also, unless, of course, the lesion is an old chronic pyonephrosis. Indeed, some of the acute pyonephroses get symptomatically well under drainage, even though the kidneys had previously given the impression of being practically destroyed. Functional tests in some of these individuals had risen from practically nothing to near normal limits within a very short time. Such kidneys, of course, will usually show positive cultures, but at any rate the individuals have been made safe for surgery.

The ureteral catheter seems to have an application for bilateral renal drainage only to non-tuberculous renal retentions, and as far as the author's experience goes, chiefly to calculus pyonephroses particularly in patients whose combined function is extremely low, and who are uræmic from profound absorption. The ureteral catheter in such instances is extremely serviceable. A recent patient whose phthalein was almost unreadable, and who was so uræmic and so toxic that death seemed almost inevitable, improved sufficiently under

# PRELIMINARY RENAL DRAINAGE WITH SPECIAL REFERENCE TO THE TWO-STAGE OPERATION ON THE KIDNEY

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It is indeed a rare privilege and high honor to offer a small contribution to this number commemorative of the life and work of Dr. Paul M. Pilcher, and I know of no subject which would more closely ally itself with the work that he has so splendidly done in recent years, than one dealing with the question of preliminary drainage. Its value in prostatic surgery for the relief of renal retention and absorption has been emphasized and its importance promulgated, in a great measure, through his unceasing efforts, until at present it is thoroughly established as the paramount feature in prostatic surgery.

Preliminary drainage of a diseased kidney before its surgical attack has, on the other hand, been dealt with very sparingly by the general profession, and has received no such heraldry as that dealing with lower obstruction. It is for this reason that a terse comment on this topic will be presented. I may have nothing novel to suggest to the urologist, but to the busy general surgeon who may not be so well posted on special affairs, it is possible that a discussion of this feature of renal surgery may be acceptable.

It appears that in the treatment of certain renal retentions and infections there is a close parallelism between the preliminary treatment before ultimate surgical attack upon the kidney itself, and of obstruction at the lower tract causing somewhat similar renal involvements, namely, the relief of such retention either by catheter drainage or by open operation.

*Ureter Catheterization.*—Almost everyone is thoroughly convinced that the ureteral catheter has a valuable application in the treatment of many types of renal disease. It seems to possess a therapeutic triad, namely: preparation, conservation and cure. In this communication its value as a preparatory measure will alone be dealt with, its importance in conservation and cure having been recently discussed in a previous article,<sup>1</sup> although one frequently encounters surprises in that often the method of preparation produces an apparent cure.

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<sup>1</sup> Journal of the American Medical Ass'n., vol. lxxviii, No. 9, March 3, 1917, p. 675.

ill and uræmic, with vomiting, headache, œdema of the lower extremities, very pasty and sallow, with fever, chills, exhaustion; X-ray showed large coral stones in each kidney, function extremely low from each, a colon bacillus infection and a small amount of retention in each kidney. She was drained and her pelvis lavaged by means of the ureteral catheter on several occasions. Later the right kidney was nephrotomized, tube drainage to the pelvis through the cortex. Kidney was slightly freed and free drainage put into the kidney space. No attempt was made to disturb the calculus. About two weeks later the stone was removed. About a month later the other kidney was drained, two weeks the stone removed. The kidneys were not drained simultaneously, nor was either stone removed with the drainage, and it is unquestionably due to this that the patient's life was saved. After each one of these short and easily executed operations, the patient showed considerable reaction, and I am perfectly confident had any too much been done in either sitting, the patient would have died. The preliminary drainage of the kidney has the same effect as drainage of the lower tract, by relieving absorption, allowing the wound to wall off by granulations and lessening engorgement and hemorrhage, and naturally making the operation less time-consuming and less shocking.

The suggestion for the two-step operation on either kidney in this type of case is the main object of this brief discussion. My patients on whom this has been done are well, and even though their function is still low, but somewhat improved, they are relieved of their symptoms and toxæmia. and I feel confident had they not been given the benefit of preliminary drainage, and very little surgery at each sitting, the story would have been different.

preliminary drainage and lavage with the ureteral catheter at repeated intervals, to be ultimately cured by a two-stage operation on either kidney.

*Two-stage Operation on the Kidney.*—It must not be understood that I am advising secondary nephrectomy as a routine method of choice. Naturally if a diseased kidney has a partner that is capable of maintaining its host's equilibrium and the diseased kidney is not so disturbed as to make its immediate removal dangerous, primary nephrectomy is the operation of choice, and is done with an exceedingly low mortality. In the author's experience it has been *nil* in a series of forty-two cases, but for a certain few, extremely ill individuals with either unilateral or bilateral involvements, the two-stage operation is unquestionably the wisest surgical move. It is very seldom in adults that we are compelled to do a secondary nephrectomy, but in children and in infants, whom we so frequently see in the St. Louis Children's Hospital, coming in with very large pyonephroses, extremely toxic, with high leucocytosis, high fever, and some so overwhelmed that fever is impossible, who look almost as though any surgical attack would be fatal, and certainly nephrectomy, preliminary nephrotomy has offered them their only chance. Quite a number of such children have been operated on in extremis without a death. The children, under gas anæsthesia, have their kidneys exposed through the lumbar incision and freely drained with tube drainage, within the kidney and around it, and contrary to custom, I have at the operation frequently freed the kidney somewhat from its surroundings. All the children have immediately improved and all have had their secondary nephrectomy in four weeks, usually two to three weeks, and only in one case has it been necessary to do an intracapsular nephrectomy. Within this time adhesions are delicate, the kidney small, and removal has been quite simple.

The two-stage operation serves its most admirable purpose in bilateral calculus pyelonephritis or pyonephrosis. With both kidneys almost completely filled with large coral stones, with the cortices greatly destroyed by inflammation, and the pelves having more or less retention, and whose combined function is extremely low, the removal of both stones at one sitting or even one of them will often be more than the individual can stand. As the author has had several extreme examples of this type of disease, he feels that the two-stage operation on each kidney is a method that should be more frequently used, even though it is so tempting to remove a branching calculus when it is palpated in the kidney. The findings in brief of a recent case exemplify the advisability of such a technic. A woman past middle life came in extremely

fibrous capsule or (2) by centrifugal veins which pierce the fibrous capsule and the renal cortex. The latter are to be regarded as accessory renal veins, able, at least in part, to assume the work of the renal vein (Téstut<sup>3</sup>). The anastomoses of the venous plexus in the fatty capsule of the kidney have been thoroughly worked out by Tuffier and Lejars,<sup>4</sup> who showed that obliteration of the renal vein might result in the formation of a collateral circulation whereby venous blood from the kidney would be carried back into the general circulation through this plexus by four routes. These are (1) the suprarenal and inferior diaphragmatic veins, (2) the ureteric and spermatic (or ovarian) veins, (3) the subcutaneous plexus of the lumbar region, and (4) the plexus which surrounds the last intercostal nerve and the ilio-inguinal and iliohypogastric nerves.

One of the earliest effects of sudden and complete obstruction of the ureter is the production of an intense hyperæmia and œdema of the kidney. The intrarenal pressure slowly rises by damming back urine which is being formed, and this in turn produces a slow but constant dilatation of the uriniferous tubules. This compresses the venous capillaries, especially those in the cortex, and serves to perpetuate the changes already started. At first only the venous capillaries are affected, but later the arterial circulation also becomes involved (Lindemann, *loc. cit.*). If then the venous apparatus both in the fat capsule and on the surface of the kidney is well developed, as, in my experience, it clearly is in the vast majority of instances, the anastomoses already described by Tuffier and Lejars (*loc. cit.*) will take up the work for which they were intended and carry on, more or less perfectly, the venous circulation of the kidney. If, on the other hand, as may occasionally happen (experimentally, once in 33 animals), this accessory venous circulation develops either not at all or but slowly, the secretion of urine soon ceases, hydronephrosis will not develop, and atrophy of the kidney will take place. The laboratory notes of the one instance in which this phenomenon was observed are as follows:

Dog. 5. Figs. 3 and 4. August 24, 1909. Young, black mongrel dog. Ether. Right ureter divided and ligated. Kidneys of equal size and of normal appearance.

October 18, 1909: Dog in perfect health. Wound healed *per primam*. Laparotomy. Right kidney considerably smaller than left, firm, normal color. *Vessels of renal capsule not engorged*. Ureter thickened, *not dilated*; left kidney has not changed in any respect.

November 20, 1909: Animal in good condition. Laparotomy. Right kidney about two-thirds its former size, abnormally firm in consistency, dark in color, *capsular vessels not engorged*. Ureter distinctly fibrous.

# THE INFLUENCE OF THE VENOUS COLLATERAL CIRCULATION OF THE KIDNEY ON HYDRONEPHROSIS

AN EXPERIMENTAL STUDY

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I HAVE already shown experimentally<sup>1</sup> that complete and sudden obstruction of one ureter by ligation results in hydronephrosis of the corresponding kidney. With few exceptions the degree of hydronephrosis varies directly with the length of time after ligation of the ureter (compare Figs. 1, 2 and 11), and, judging by the results seen in two dogs which were allowed to live 247 and 258 days, respectively, the hydronephrotic sac will continue to increase in size for a very long time.

In all of these cases the fibrous capsule of the hydronephrotic kidney is found to be overlain by a network of engorged veins not demonstrable before operation. In some instances this venous plexus shows remarkable development (Figs. 1 and 2\*), while in others it is less apparent (Fig. 11). By injection with gelatine these veins are found to form anastomoses with others, notably the spermatic (or ovarian), the adrenal, and two or three lumbar veins posterior to the kidney (Figs. 1 and 2). It became apparent early in my work that there was a very intimate connection between the development of the hydronephrotic sac and the venous plexus, and, when the latter was absent or but poorly developed, there was generally a correspondingly small hydronephrosis. Lindemann,<sup>2</sup> in 1895, had already made this observation, but his evidence was based largely on microscopic evidence.

A consideration of the venous apparatus of the normal kidney will help to explain the phenomena observed. There arise on the surface of the kidney, innumerable clusters of venous capillaries, having a star-shaped arrangement (*étoiles de Verheyen*), each emptying into a central vein and thence entering the kidney by the interlobular vein. The fatty capsule of the kidney contains a rich plexus of veins and these empty on the one hand into the renal vein or one of its branches, and on the other directly into the kidney substance, either (1) through connections with the star-like capillaries of the

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\* Figs. 1, 2, 3 and 4 are from specimens obtained in a previous experimental work and have already been published.<sup>1</sup>

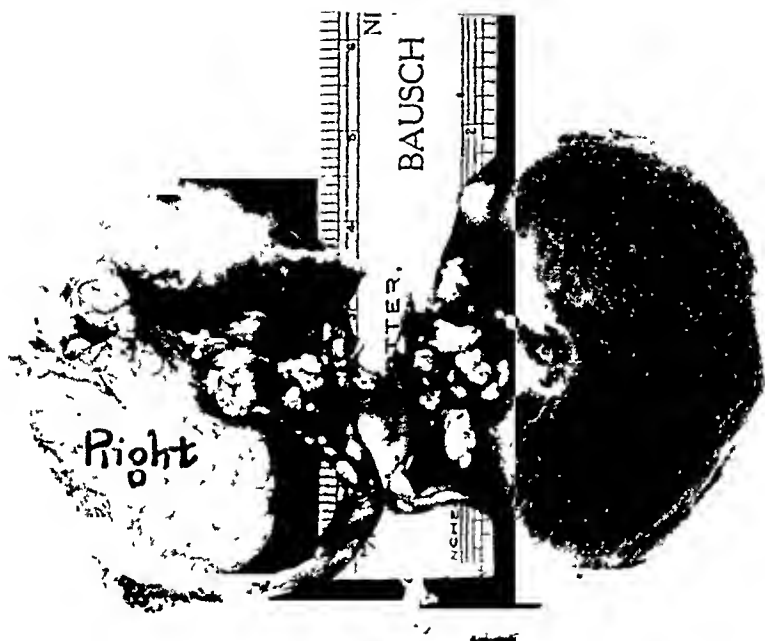


FIG. 3.—Dog 5. Eighteen weeks after division and ligation of right ureter. Compare with Figs. 5 and 7. In this case the veins of the kidney were undisturbed, but at no time did they show evidences of engorgement or of anastomoses so well shown in Figs. 1 and 2. Right kidney about one-third smaller than left, no dilatation whatever of ureter or pelvis.

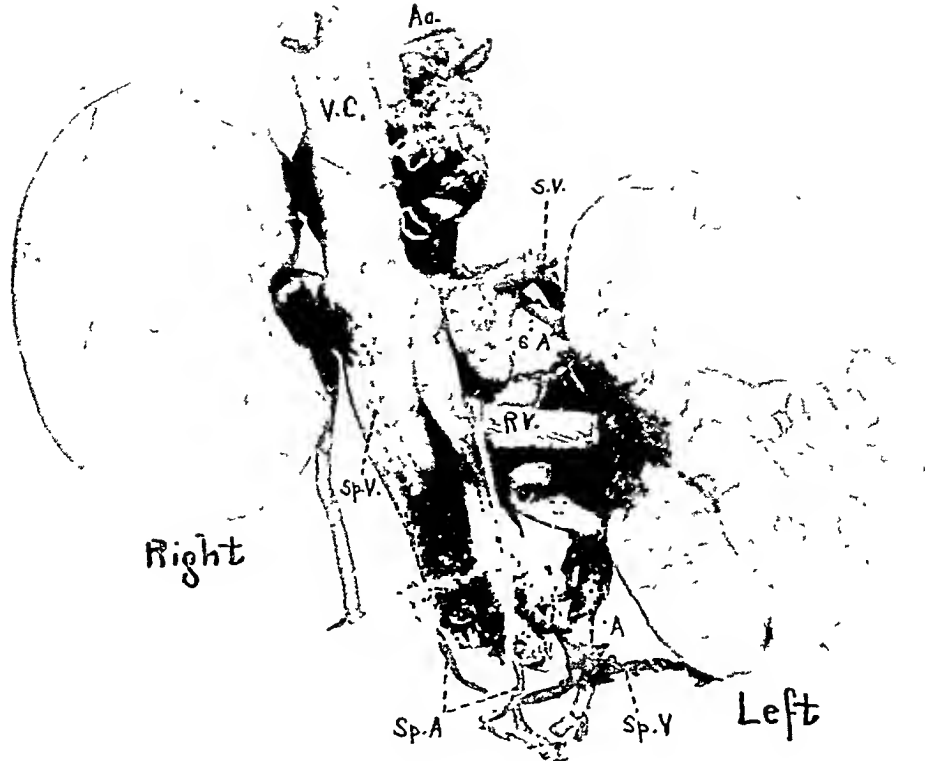


FIG. 1.—Dog 26; male. Eleven days after ligation and division of ureter. Left hydronephrosis. Anterior view. Injection of vessels. Nephroptosis on left. Tortuosity of left ureter, *A*. Note branch of spermatic vein, *Sp. V.*, going to lower pole of kidney, and suprarenal vein, *S. V.*, supplying upper pole; *V. C.*, vena cava; *Aa.*, aorta; *R. V.*, renal vein; *Sp. A.*, spermatic artery; *S. A.*, suprarenal artery. No engorgement of vessels of right kidney.

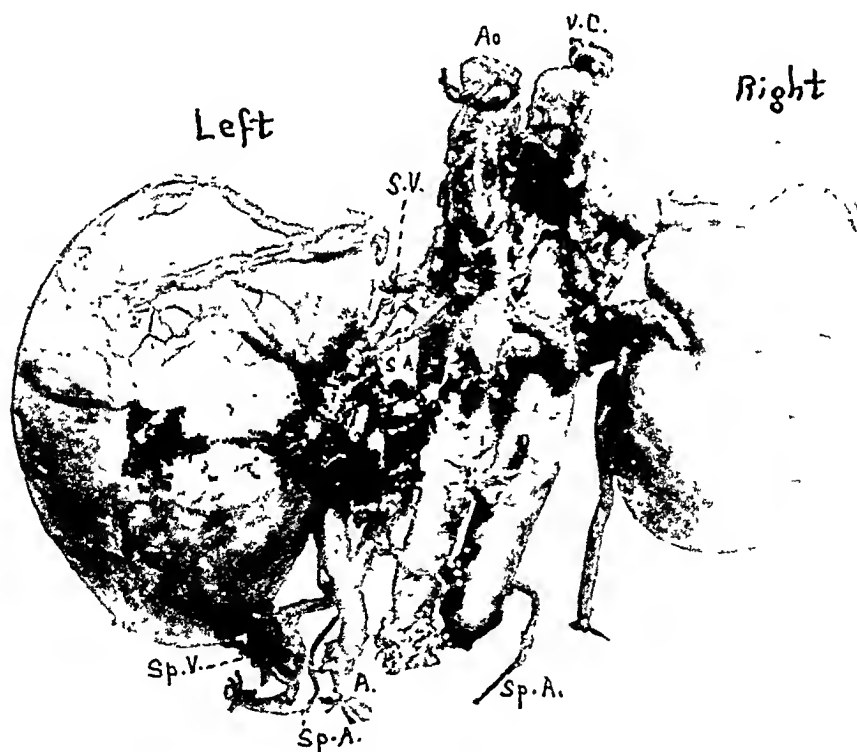


FIG. 2.—Dog 26; male. Eleven days after ligation of ureter. Left hydronephrosis. Vessels injected. Posterior view. Shows size, number and distribution of vessels on posterior aspect of kidney. Compare with anterior view, Fig. 1.





FIG 5.—Dog 3. Fifty days. Ligation and division of right ureter and of spermatic, supra-renal and two or three lumbar veins posterior to the kidney. Considerable perinephritis. Right kidney about one-third smaller than its fellow, ureter considerably dilated, but no evidence of engorgement of capsular veins.



FIG 6 —Section of right kidney shown in Fig. 5. No dilatation of pelvis or of calyces. Kidney substance is infiltrated with fat and fibrous tissue.

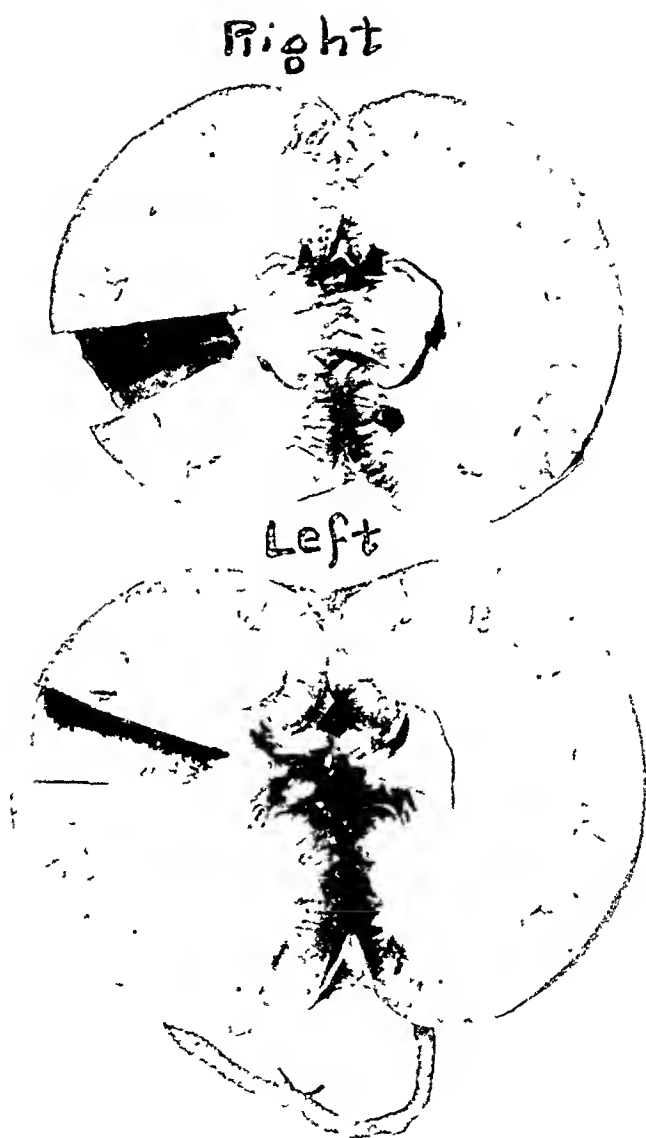


FIG. 4.—Section of right kidney shown in Fig. 3. Note the difference in size between it and the normal (left) kidney below. No dilatation of pelvis or of calyces. Renal substance infiltrated with fat and fibrous tissue and normal markings are almost entirely obliterated.



FIG. 9.—Dog 7. Fifty days. Ligation and division of right ureter and also of spermatic vein suprarenal vein and of two or three lumbar veins posterior to the kidney. Right kidney is much smaller than the left, but the pelvis and ureter are dilated. No engorgement of capsular veins of kidney.



FIG. 10.—Interior of right kidney shown in Fig. 9. Moderate degree of hydronephrosis.



FIG. 7.—Dog 4, control. Fifty days. Ligation and division of right ureter. Capsular veins moderately engorged, ureter and pelvis somewhat dilated, moderate degree of hydronephrosis.

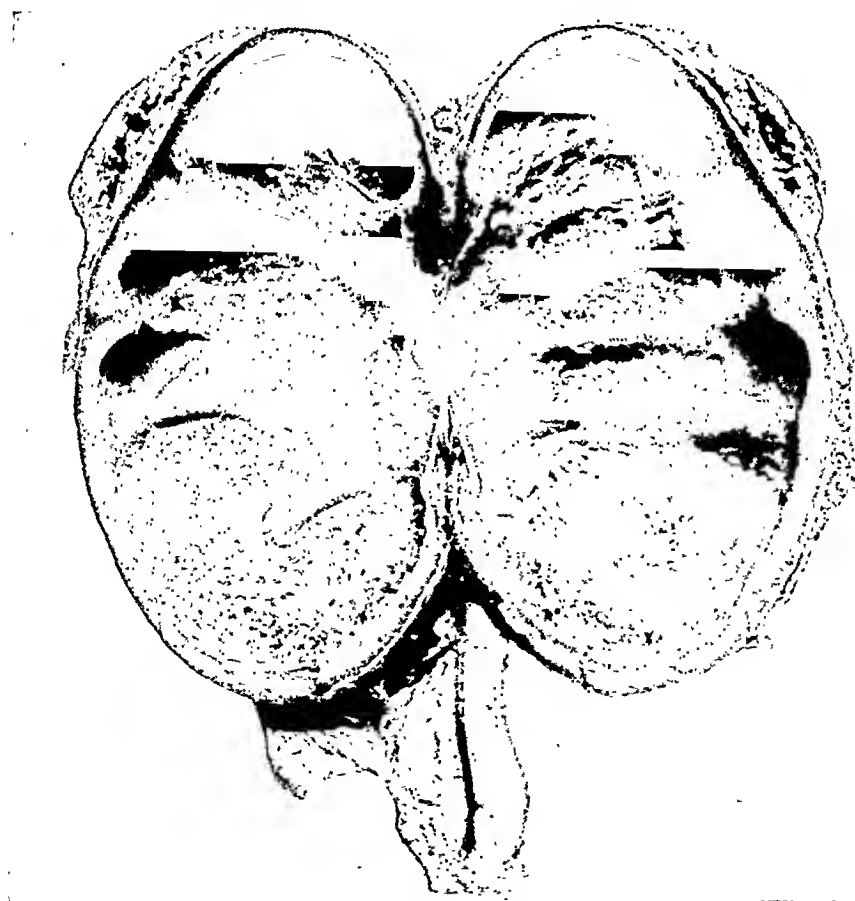


FIG. 8.—Interior of right kidney shown in Fig. 7. Renal cortex much thinned.





FIG. 11.—Dog 8, control. Fifty days. Ligation and division of right ureter      Capsular veins  
much engorged. Hydronephrosis.



FIG. 12.—Interior of hydronephrotic kidney shown in Fig. 11. Renal cortex much thinned, pelvis  
much dilated.

January 2, 1915 (50 days): Dog has been in good health. Sacrificed with strychnine. Right kidney about one-third larger than left, elastic, pelvis and ureter dilated, *veins of capsule moderately engorged*, corresponding in their relation to the degree of hydronephrosis with my previous findings in such cases (Fig. 7). A section of this kidney, Fig. 8, shows typical hydronephrosis of moderate size.

Dog 7. November 24, 1914. Same technic as in Dog 3.

January 13, 1915 (50 days): Dog in good condition. Sacrificed with strychnine. Right kidney much smaller than left, *no dilatation of capsular vessels*. Considerable dilatation of the ureter, which is tortuous, and of the pelvis, which is largely extrarenal (Fig. 9). A section of this kidney (Fig. 10) shows an early stage of hydronephrosis, corresponding in its development to that which I have often obtained before, a few days after ligating the ureter. Thus, while the size of the kidney still was less than before operation, a change which may be regarded as atrophy, it is not the example of true atrophy and cessation of function seen in Dog 5 and Dog 3.

Dog 8. Control. November 24, 1914. Same technic as in Dog 3, but veins were not ligated.

January 13, 1915 (50 days): Dog in good condition. Sacrificed with strychnine. Marked hydronephrosis on the right, the kidney being twice the size of its fellow. *Capsular vessels much engorged* (Fig. 11), but these vessels do not show up well in the photographs. A section of the organ (Fig. 12) shows the typical appearances of hydronephrosis. The kidney substance is thinned out to a mere shell and the pelvis is traversed by fibrous bands which carry the blood-vessels. The left kidney, although deeply injected, seemed otherwise normal.

It is obvious from these experiments (Dogs 3 and 7) and from my earlier work (Dog 5), that if the venous collaterals of the kidney do not develop, or if their formation can be prevented after occluding the ureter, hydronephrosis will not develop, and renal atrophy will take place.

These observations bear out the statements so often seen in the textbooks, that sudden and complete occlusion of the ureter produces atrophy of the kidney, whereas partial or intermittent occlusion results in hydronephrosis. An investigation of the clinical aspects of this question which I made some years ago<sup>5</sup> showed that while sudden and complete obstruction of the ureter by ligature or clamp produced hydronephrosis in most cases, its development was rarely extensive. In fact, it was found that many surgeons had accidentally or intentionally tied off a ureter without disturbance to the patient either immediate or remote. It is obvious, therefore, that the results of the operating room differ from those of the laboratory. These experiments may also explain why it is that the hydronephrosis resulting from partial or intermittent obstruction of the ureter is of larger size than that seen when the obstruction is complete and sudden.

## COLLATERAL CIRCULATION IN HYDRONEPHROSIS

December 28, 1909: In good health. Has gained weight. Laparotomy. Right kidney has not changed since last note, in size, color or consistency, but is about two-thirds size of left. No dilatation of its pelvis or ureter. Left kidney normal. Animal killed.

On section the right ureter is thick and fibrous, and contains a little grumous material. The kidney is fully one-third smaller than the left, pale, distinctly fibrous, its normal markings are obliterated, and there is no dilatation whatever of its pelvis. The latter contains a few cubic centimetres of thick, cloudy fluid of urinous odor.

Here, then, is an example of true renal atrophy, and it occurred to me at that time that if such a result would take place spontaneously it might also be produced artificially by preventing the formation of the venous anastomoses already described. I can find no evidence in the literature that this problem has been investigated before.

In the fall of 1914, through the courtesy of Professor E. H. Nichols, to whom I am deeply grateful, this work was undertaken in the Laboratory of Surgical Pathology at the Harvard Medical School. Four pairs of dogs were operated upon (one of each pair being used as a control). As the results in the first and third pair were entirely vitiated by sepsis and otherwise faulty technic, the laboratory notes of only the second and fourth pair will be given.

Dog. 3. November 13, 1914. Ether. Four-inch incision through upper border of right rectus muscle. Ureter isolated through an incision in overlying peritoneum, and divided about 2 inches below the kidney between 2 ligatures of No. 1 chromic catgut. The spermatic vein was then ligated and divided close to its entrance to the vena cava, and a small group of veins at the lower pole of the kidney, found by previous experience to anastomose with the spermatic vein, were also tied and divided. The suprarenal vein and a group of two or three lumbar veins posterior to the kidney were also ligated and divided, linen thread being used throughout. The abdominal wound was closed in two layers.

January 2, 1915 (50 days): Dog has been well. Sacrificed with strychnine.

Right kidney pale, size of plum, much smaller than before operation and smaller than left kidney. Considerable perinephritis. Ureter tortuous, moderately dilated. No demonstrable dilatation of pelvis. *No dilatation of capsular vessels* (Fig. 5). Left kidney is unusually dark in color, but otherwise seems normal.

On section (Fig. 6) the right kidney is found to be much smaller than its fellow, its pelvis and calyces of normal size and filled with a thick, grumous material. The kidney substance, especially the cortex, is extensively infiltrated with fat and fibrous tissue, and the specimen as a whole is quite comparable to that of Dog 5 (Fig. 4), occurring spontaneously in my earlier series of experiments. The pathology of these specimens is purposely omitted here as it is considered worthy of a special communication to be made later.

Dog 4. Control. November 13, 1914: Same technic as with Dog 3, but veins were not ligated.



# AN UNUSUAL CASE OF RENAL TUBERCULOSIS

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AND

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IN view of the fact that renal tuberculosis commonly masquerades under remote, unrecognized or misinterpreted urinary symptoms, and that it requires at times all the armamentaria at the command of the genito-urinary surgeon to arrive at a correct diagnosis, we have thought this case history of sufficient interest to report, owing to the fact that in spite of greatest thoroughness and precautions, the diagnosis was not correctly made until operation was undertaken. The possibility, by virtue of X-ray revelations, of confusing renal and ureteral tuberculosis with calculus of the kidney or ureter is well known to urologists and röntgenologists, but the error of mistaking a calcified plaque in the internal iliac artery for a ureteral calculus, which subsequently proved at operation to be a reno-ureteral tuberculosis without calcification, is, in the experience of the writers, a novel if not an excusable diagnostic blunder.

Charles R., white, aged sixty-two, referred by Doctor James E. Talley, was admitted to the Polyclinic Hospital, December 2, 1916, with the following history.

*Chief Complaint.*—Attacks of frequency and burning on urination, associated with pain in back.

*History of Present Illness.*—Symptoms date from 1912, but patient had backache as long as he can recall. He has been cystoscoped by his physician five times. Pain has been localized chiefly to left of costovertebral angle; never radiated to genitalia; often, however, transversely to midline. Urination and burning has been more frequent since cystoscopies were performed. At present he urinates every one and one-half hours.

*Family History.*—Negative.

*Previous Medical History.*—His only serious illness was typhoid fever in 1901.

*Physical Examination.*—Well-developed adult male; robust and plethoric in appearance. Lungs show no evidence of impairment. Heart is normal. Abdomen appears normal to inspec-

## COLLATERAL CIRCULATION IN HYDRONEPHROSIS

In the one case the intrarenal venous circulation is relieved of the embarrassment brought upon it by the encroachment of the slowly dilating uriniferous tubules, the extrarenal venous anastomoses have an opportunity to develop, and the secretion of urine is augmented, rather than decreased, owing to the change in the venous circulation. This accounts for the fact, so commonly seen, that the kidney whose ureter is but partially or intermittently obstructed may attain a sometimes enormous size, and also explains why it is that polyuria occurs in the kidney so affected. This polyuria is commonly observed both clinically and, in my experience, experimentally, the urinary secretion restoring itself gradually to a normal amount when the ureteral obstruction is removed and the venous circulation is no longer embarrassed.

If, on the other hand, the obstruction to the ureter is complete, sudden and permanent, tubule dilatation is pronounced, the intrarenal venous circulation is severely embarrassed, and before the extrarenal anastomoses are fully developed urinary secretion may almost, if not entirely, cease. While in most cases, as I have shown, these anastomoses develop rapidly and to a marked degree, resulting in hydronephrosis of considerable size, they may rarely fail to respond to the extra demands made upon them. In this event urinary secretion ceases almost entirely and atrophic and degenerative changes take place in the kidney.

The conclusions to be drawn from these observations are:

1. Sudden, complete and permanent obstruction of one ureter produces hydronephrosis in animals in the vast majority of cases, but
2. Atrophy of the kidney may develop in rare instances.
3. When hydronephrosis occurs the venous collaterals of the kidney are well developed; when atrophy of the kidney takes place it is due to a lack of development of these collaterals.
4. Atrophy of the kidney may be produced experimentally, by simultaneous ligation of the ureter and of the veins which maintain the collateral venous circulation of the kidney.
5. When the obstruction to the ureter is partial or intermittent the hydronephrosis is of greater size than when the obstruction is complete, sudden and permanent, for in the latter event, urinary secretion ceases before the venous collateral circulation has time to develop.

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<sup>3</sup> Téstut: *Traité d'Anatomie Humaine*.  
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of 0.4 per cent. solution) showed elimination of the dye from the right ureteral orifice within normal time limits, but no elimination from the left ureter for over twenty minutes. Indeed, no function at all was visible on the part of the left ureter. An attempt to insert a skiagraphic catheter in the left ureter was frustrated by a definite obstruction  $2\frac{1}{2}$  centimetres above the orifice.

Subsequent skiagraphic plates confirmed the pea-sized shadow observed in the original X-ray plates (Fig. 1). No shadows in the line of the ureter or the kidney above were visible.

The patient was advised to undergo operation for removal of calculus in lower portion of left ureter, and on January 25, 1917, the operation was undertaken.

A left inguinal incision was made. The peritoneum was reflected toward the midline, but did not lift the ureter, as is normally the case, inasmuch as it was found to be fixed by adhesions to the pelvic and lumbar tissues. The vas deferens was identified and traced downward. A small hard mass was encountered in the region of the internal iliac artery, and on exposure and palpation revealed a calcified plaque just below the bifurcation of the common iliac artery. The ureter, because of its size and the surrounding inflammation, was not surely identified until it was traced down from the kidney. The ureter was found to be greatly thickened and obviously tuberculous; no calculus was palpable. The inguinal incision was extended upward, and the kidney, not palpably diseased, save for dense adhesions about upper half, was, on inspection, observed to be mildly lobulated. Adhesions were separated from the diaphragm and peritoneum with great difficulty, tearing the latter for a distance of four inches; the rent was immediately sutured. The ureter was severed by cautery low in the pelvis between two ligatures. The vascular pedicle was then ligated and the kidney and ureter removed *in toto*. The wound was closed about drainage tubes inserted in the upper and lower angles.

Patient made uneventful recovery; was discharged and returned home on twenty-first day with a small sinus, which healed a week later.

*Examination of Pathological Specimen.*—Kidney on mesial section from pole to pole showed caseous cavernous renal tuberculosis. Many tubercles were seen in the vascular zone between the cortex and medulla of the organ. In a few cases the foci showed caseation and caverns filled with pus. Some of the cavities extended into the renal pelvis with resultant ulcerations and pus in that structure. The entire ureter was involved in the tuberculous process, was greatly thickened and markedly strictured.

The suprarenal gland, imbedded in and firmly adherent to a mass of

## RENAL TUBERCULOSIS

tion, palpation and percussion, including lumbar regions. Nervous system is negative. No abnormality by rectal palpation; genitalia likewise normal. Pulse is regular, somewhat hypertonic, but of normal rate. Blood-pressure: Systolic, 170; diastolic, 96.

The skiagraphic plates presented by the patient and taken at another hospital showed a shadow the size of a pea in the region of lower left ureter.

A urinalysis report, dated January 25, 1912, showed the urine to be acid; specific gravity, 1020; trace of albumen; very many leucocytes; no casts; no sugar; urea, 1.770. Another report, dated February 8, 1916, was as follows: Acid; specific gravity, 1017; pus; urate crystals; urea, 1.870. Our urinalysis, at time of admission, showed an acid urine with a specific gravity of 1015; a cloud of albumen; no sugar; a few red blood-cells and pus. Hæmoglobin 78 per cent.

After admission to the hospital the following functional kidney tests were performed.

*Indigocarmin.*—Intramuscular injection of 20 c.c. of a 0.4 per cent. solution appeared per catheter in twenty-four minutes, and quantitatively as follows:

First hour .....	5.31 per cent.
Second hour .....	9.43 per cent.
Third hour .....	6.25 per cent.
Total .....	<u>20.99</u> per cent.

*Blood: Non-coagulable protein*, 58 mgm. per 100 c.c.; *urea nitrogen*, 22 mgm. per 100 c.c.; *creatinin*, 3.2 mgm. per 100 c.c.

*Cryoscopy: Blood*  $\alpha = 0.50$ ; *urine*  $\Delta = 1.05$ .

*Urine: Urea nitrogen*, 140 mgm. per 100 c.c.; *Urea Doremus*, 14.5 mgm. per 1 c.c.

December 9, 1916: *Phenolsulphonephthalein*: Intramuscular injection of 1 c.c. appeared per catheter in nineteen minutes, and quantitatively as follows:

First hour .....	7.50 per cent.
Second hour .....	12.50 per cent.
Third hour .....	17.50 per cent.
Total .....	<u>37.50</u> per cent.

January 9, 1917: Patient was advised to have other skiagraphic plates made with a skiagraphic catheter in the left ureter. Cystoscopy at this time revealed the bladder to be the seat of low-grade inflammation, more marked in the region of the trigonum. Chromo-ureteroscopy employing indigocarmine (20 c.c.

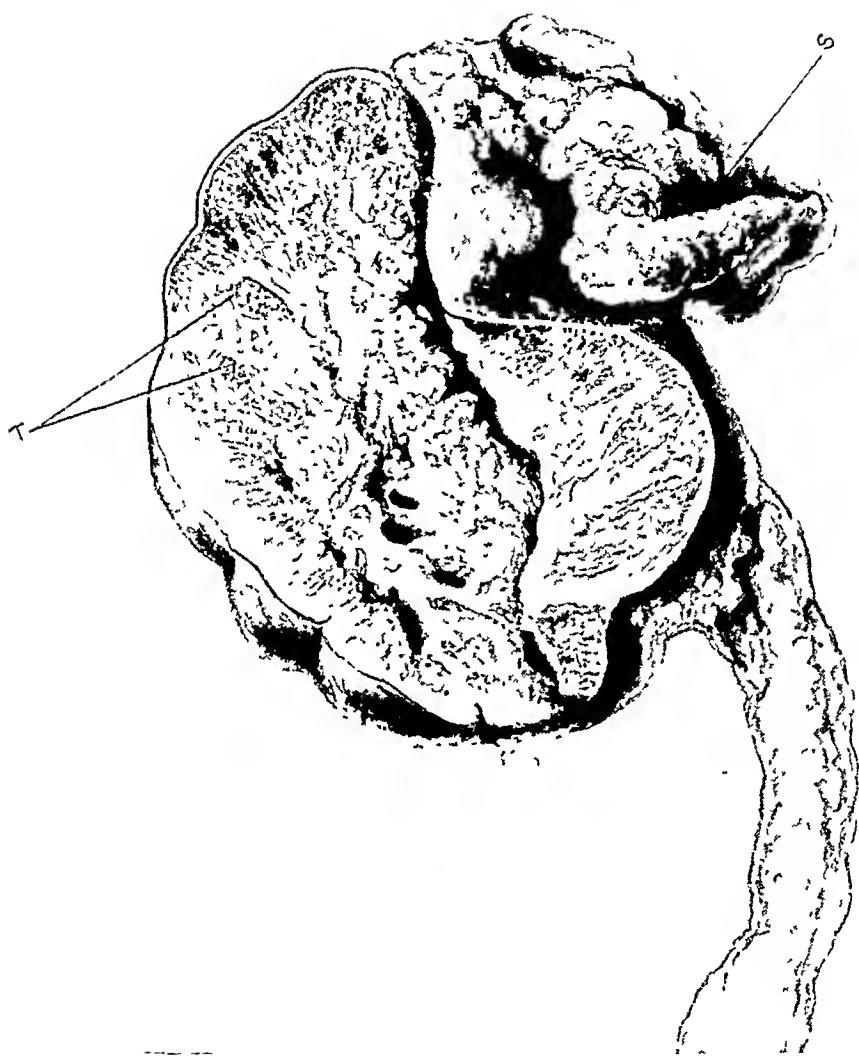


FIG. 2.—*T*, tuberculous cavities in kidney parenchyma; *S*, abscess cavity in suprarenal gland.



FIG. 1.—Skiagram showing shadow of plaque in internal iliac artery. Certain features of this shadow if more carefully observed might have helped us in avoiding our error, viz.: the ragged upper extremity and its axis extending downward instead of inward in direction of the bladder.



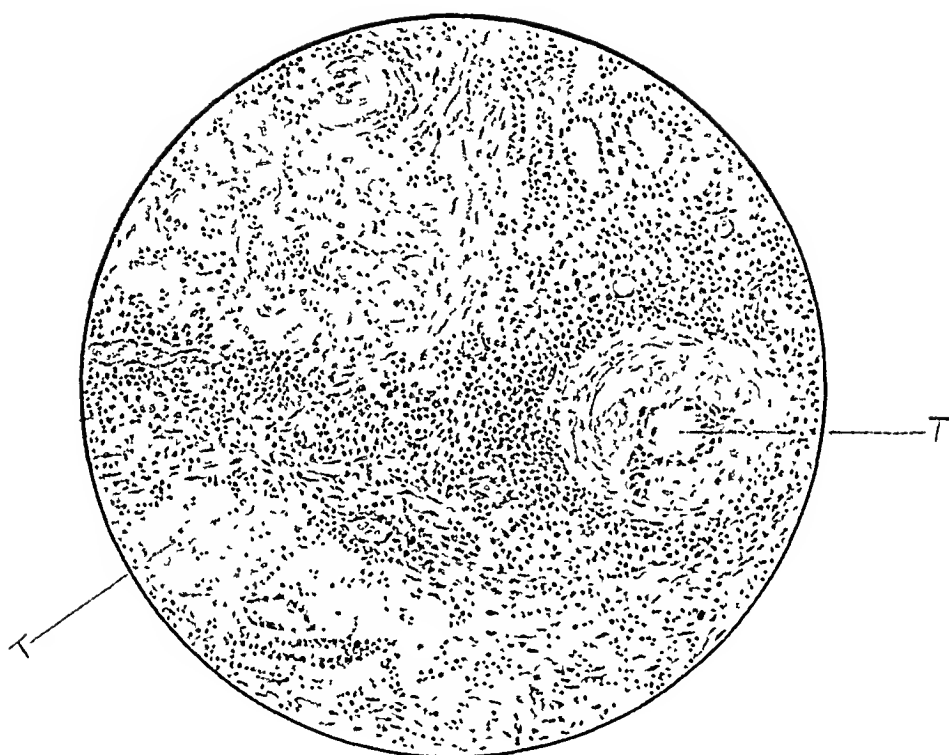


FIG. 3.—*T*, tubercles in kidney parenchyma. (Drawing from microscopical slide.)



## BILATERAL RENAL CALCULI

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THE first renal calculus was removed from the living subject as recently as 1880, by Henry Morris, England. The first successful skiagraph of a renal calculus was made by McIntyre, Glasgow, 1896. Until radiographic technic had made considerable progress, diagnosis of renal calculus was uncertain, and many a surgeon expecting to remove a stone from a kidney was disappointed to find tuberculosis, tumor, cysts, or essential hæmaturia. We have at our command as aids to diagnosis, in addition to clinical symptoms, the cystoscope, renal function, and the X-ray; the greatest of these is the X-ray.

If every patient presenting typical symptoms of renal calculus were operated upon, there would be a very high percentage of disappointments, as we know that less than 50 per cent. of patients sent to the radiographer with a suspected renal calculus are reported back, positive.

Calculi vary in size from a grain of sand to several pounds, and in number from 1 to 40,000 (Sutton).

Bacterial infection of the kidney or its pelvis is a potent factor in the development of these calcareous deposits.

Bilateral renal calculi are found in 15 to 20 per cent. of all cases. Kummel in 101 consecutive cases of renal calculi found both kidneys involved in 16 instances. Bevan states the frequency is one in five, or 20 per cent. Joseph in making postmortems on infants from three and a half to eighteen months of age, found 40 with renal calculi and 23 bilateral, which is more than 57 per cent. It is known that many infants have calcareous deposits which disappear before they are many months old, thus probably accounting for the high percentage in infants.

A most interesting and unusual case of the appearance and disappearance of calcareous deposits in both kidneys and one ureter is reported by Newboldt (*British Jour. of Surg.*, vol. i, p. 334).

Man, twenty-eight, fractured right femur and tibia, non-union. After having been on his back for eight months, complained of pain in both loins and urinary bladder. Radiograph showed definite shadows in both kidneys and left ureter. Albumen, blood, and pus cells in urine. An acute attack of severe pain precipitated a few weeks later by riding several miles in a motor car. He was given nitromuriatic acid, aerated water, sour milk, and four lemons a day. During the

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perirenal fat, was enlarged to several times its normal size. Section of the gland revealed an abscess cavity containing several drachms of caseous and purulent material (Fig. 2).

The microscopical drawing (Fig. 3) shows a number of typical tubercles located in the parenchyma of the kidney.

The post-operative review of this case presents the following points of interest: (1) A strictured or almost completely closed tuberculous ureter which by virtue of the correlation of the X-ray shadow and the level at which the catheter was obstructed permitted of the diagnosis of ureteral calculus; (2) an abscess of the suprarenal gland associated with the renal tuberculosis, but with no manifestation of Addison's disease.





FIG. 1.—Bilateral renal calculi, composite. Skiagraph showing both lumbar regions.



FIG. 3.—Four small ureteral stones to left were passed into bladder and per urethram. Fifteen months later the large round stone was removed from the urinary bladder. Six years later the remainder of calculi in this group were removed from both kidneys.

that a calculus of considerable size can develop in a comparatively short time (Fig. 3).

During the next four years the patient experienced four attacks of renal colic with symptoms referred to the left side twice and twice to the right side. These attacks were made tolerable by hypodermic administrations of morphine, and each terminated with the passage of one to three calculi.

I did not treat him from 1909, when the large vesical calculus was removed, until October 12, 1915, when in consultation I found him reduced to a mere shadow, suffering great pain, thoroughly septic, urine loaded with pus, and large palpable mass in left renal region, which was diagnosed as pyonephrosis. The accompanying radiographs, by Dr. Sidney Lange (Fig. 1), revealed several calcareous deposits in both kidneys with consider-

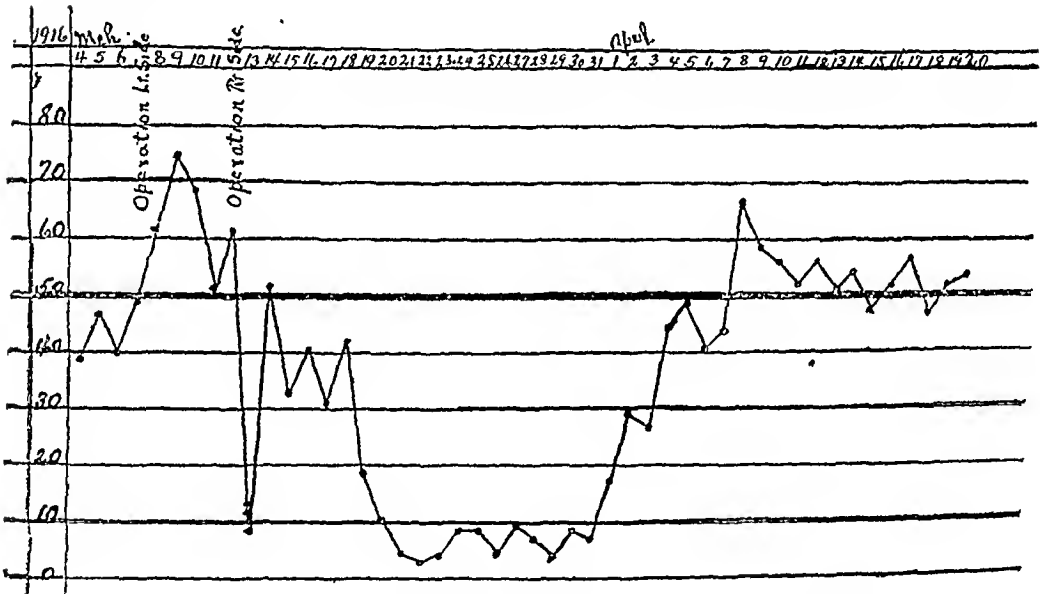


FIG. 2.—Showing daily urinary secretion in ounces by column of figures on left.

able renal enlargement. Every urological radiographic examination should include both kidneys, ureters, and bladder. On account of the very poor condition of the patient the left side was incised under local anæsthesia, a pyonephrotic sac opened and about 400 c.c. of thick, yellow pus removed with two calculi. The condition of the patient did not warrant further treatment at this time. A large-sized drainage tube was introduced after irrigating the sac, and the wound closed. Improvement was prompt and rapid. Tube removed at end of one week, patient left the hospital one week later and continued to improve until he had regained his lost weight and felt as strong as ever within two months. Urine, of course, remained cloudy. For three months he went

## BILATERAL RENAL CALCULI

next few weeks he passed calcareous deposits with the urine. Two months later patient was entirely comfortable, urine normal, had regained his weight and radiographs negative. No recurrence months later.

That bilateral renal calculi may be present for a long period of time, cause the patient but little discomfort, and so completely destroy the kidney parenchyma that the patient dies from renal inefficiency, is evidenced occasionally in the post-mortem room. Less frequently now than formerly, thanks to the general geographical distribution of radiologists and urologists.

The following report of a case of multiple and repeated urinary calculi with development of bilateral renal calculi illustrates a number of interesting features pertaining to this subject.

W. R., adult, male, small stature, never weighing more than 120 pounds, amateur light weight pugilist and champion roller skater. His family history has no bearing upon his condition, except a younger brother at two years of age had a vesical calculus that became lodged in the urethra and was removed with some difficulty. The brother is now twenty-four years of age and has had no recurrence of urinary calculi.

He had the ordinary diseases of childhood. When six years of age was hit over the left kidney with a snowball. Immediately felt severe pain in region of left kidney. Pains would come and go, lasting from five minutes to several hours. No history of hæmaturia at that time. Says he had "kidney trouble" as early as eight years of age, but could give no definite account of the nature of the trouble. At age of twelve, passed a calculus size of a small bean, *per urethram*. When nineteen years of age had a mild urethritis which cleared up in three weeks without complications.

In May, 1909, when nineteen years of age, he came to me complaining of symptoms that suggested left-side renal or ureteral calculus. Radiographs were made which showed four separate and distinct shadows of calculi in the left ureter near the pelvic brim. Rest of the urinary tract negative. About one week later the patient was prepared for surgical removal of these calculi. A few hours before the time of operation, another radiograph was made and, much to the delight of all concerned, these four stones had gone from the left ureter into the bladder. This emphasizes the importance of radiographs of ureteral calculi just before operating. These four small stones were passed *per urethram* within a few days (Fig. 3).

Fifteen months later a stone as large as a small egg was removed, suprapubically, from the urinary bladder. This illustrates

SUMMARY.—This patient received an injury over the left kidney which may or may not have had some bearing on the later developments. At age of twelve passed a urinary calculus and soon became a veritable stone quarry, until one kidney was totally destroyed and the other one-half destroyed. Contrary to Watson's suggestion, the worse side was operated first in this case, as there was the location of the pus which was causing the symptoms of sepsis. There was no diminution of kidney activity until the only kidney tissue was damaged surgically, and that came back within twenty-four hours. This case is a clinical demonstration of what Martin Fischer has shown experimentally with the rabbit, and that is that less than one-half of the entire kidney tissue can continue a normal urine output.

along very nicely, happy in the thought that he was well, as he was not told that the right kidney also had several stones in it.

March 4, 1916, he entered the Cincinnati General Hospital suffering great pain in left renal region, where a mass was again palpable. His general condition was so much better than at the previous operation in October that he was given a general anæsthetic, the left lumbar region incised and about 350 c.c. of pus removed from the old pyonephrotic sac. Careful exploration could now be made and all stones removed. No normal kidney tissue found. Flushing and drainage as before. Practically no shock or post-operative disturbances.

Five days later the right kidney was exposed. A large mass was brought up which proved to be an hydronephrosis. There was about one-half the normal amount of renal tissue present. The larger calculi were removed through a kidney incision and many smaller ones were flushed out. Drainage tube inserted into pelvis, kidney incision closed around the tube. Lumbar incision was closed. There was considerable surgical shock following this operation. The chart (Fig. 2) is a graphic illustration of the urine output. It is worthy of note that there was no diminution of urine secretion following the operation on the left side where there was no renal tissue, also that there was only eight ounces in the twenty-four hours following the operation on the right, the only kidney present, and that this renal parenchyma although traumatized, incised, and irritated with a foreign body, the drainage tube, secreted 52 ounces during the second twenty-four hours. This small amount of kidney tissue, about one-half of one kidney, continued to put out a normal quantity of urine. The apparent drop in daily output, as shown by the chart, was caused by the urine practically all coming through the wound into the dressings; as the wound healed the urine again came the natural way and in normal quantities.

The patient regained his strength rapidly and was soon busily engaged in the management of a restaurant, apparently as well as he ever was.

About ten months after the last operation he had two attacks of right renal colic, each lasting about thirty-six hours, during which time there was complete anuria. The attacks terminated suddenly with the expulsion of a mucous plug and the passage of large quantities of urine.

These experiences verified the statement that there was no active kidney tissue on the left side; while the right ureter was obstructed with a mucous plug there was no urine.



Microscopically, it contained a few red cells and crystals of uric acid.

*Cystoscopy.*—The bladder was normal and there were no changes about either of the ureteral orifices. A No. 5 ureteral catheter was passed a distance of 5 cm., at which point an obstruction was met. With considerable manipulation this was passed and the catheter advanced to the pelvis of the kidney. A No. 6 catheter was afterwards passed. There was some bleeding alongside the catheter during this manipulation. Following this catheterization there was rather severe renal colic lasting several hours. An X-ray examination made four days later showed no change in the position of the stone. After an interval of fifteen days the left ureter was catheterized again and 5 c.c. of a 2 per cent. solution of papaverin hydrochloride was instilled through the catheter. There was no colic following this manipulation. Six days later, cystoscopy showed a stone presenting at the ureteral opening, but not projecting sufficiently to be grasped with forceps. A catheter was again introduced, pushing the stone slightly back into the ureter and papaverin sulphate, 5 c.c., was again instilled. This was seen to escape along the side of the catheter, but no dilatation of the orifice was observed. Following the second injection there was no pain immediately afterward or later. And the gastro-intestinal symptoms cleared up completely. Subsequent X-ray examination showed that the shadow in the ureter was absent and now appeared low down in the bladder area. Cystoscopy four days later confirmed the findings of the X-ray and revealed the stone about the size and shape of a peanut (meat) lying on the floor of the bladder. This was too large to pass over a slightly enlarged prostate. It was easily removed with a Young's rongeur.

CASE II.—J. A. E., a lawyer, forty years of age, in September, 1916, was seized with a sudden, severe pain in the left kidney region radiating down along the course of the ureter. Pain was controlled by a hot water bottle. Next day he vomited after eating. One month later he had a similar attack. At this time he had a thorough examination of the intestinal and urinary tracts. Physical examination revealed nothing, but the radiographs showed a shadow low down in the pelvic ureter. Fresh red cells were found in the urine at this time. When the patient came under observation, November, 1916, he was feeling fine but wanted matters cleared up. Physical examination was negative. The urine was clear, 1005, acid, and negative for albumen. An occasional red blood-cell was seen in the centrifuged specimen. In the absence of pain or kidney infection he was advised to await developments. In January, 1917, he was seized with another attack of pain similar in character and location. A feeling

## EXPERIENCE WITH PAPAVERIN IN THE TREATMENT OF URETERAL CALCULUS

BY HARRY ATWOOD FOWLER, M.D.

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I HAVE recently employed papaverin in three cases in the treatment of calculus of the ureter. The results have been so successful and prompt that I am led to believe that the expulsion of the calculus following the use of this drug is more than a mere coincidence. The more so as ureteral catheterization and the injection of sterile oil into the ureter, previously employed in the first case, had no apparent effect in changing the position of the stone.

My attention was first called to the use of the papaverin in cases of stone in the ureter by the report of Macht and Geraghty (*Johns Hopkins Hospt. Bulletin*, 1916, xxvii, p. 119). Before I had occasion to try out the preparation a further report on its use in three cases was made by Walther (*The Urologic and Cutaneous Review*, September, 1916). I have seen no further reports on its use in the literature, though doubtless it has been used by others.

A brief summary of my three cases follows:

CASE I.—Maj. C. M. S., seventy-two years of age, was seen in consultation with Dr. Prosperi, with a diagnosis of stone in the left ureter. For several weeks he had suffered with severe attacks of general abdominal pain. Each attack was accompanied by gastro-intestinal symptoms: nausea, vomiting, flatulence, and loss of appetite. During this period of his illness another physician had suspected some intra-abdominal lesion. An X-ray examination of the gastro-intestinal tract was made and nothing abnormal was found. It was particularly noted that the pain was relieved by enemata and the passage of a great amount of flatus. A general surgeon saw the patient at this time, but was unable to find any definite signs of a lesion of the abdominal viscera. The condition was therefore thought to be due to indigestion. Dr. Prosperi saw the patient in a violent attack of pain, sudden in onset, referred to the left kidney region and radiating to the left groin. The obvious diagnosis of renal calculus was made and an X-ray examination of the urinary tract ordered. This examination showed a shadow in the course of the lower left ureter. This shadow in the first plate was overlying the edge of the sacrum and could have been easily overlooked. At the time the patient came under observation the urine was macroscopically clear as water.

met an obstruction, which finally was passed and the catheter advanced to 20 cm. Withdrawing the catheter to a point just above the obstruction, 3 c.c. of papaverin hydrochloride was instilled. There was no pain following this manipulation. A few days later the stone was expelled per urethram.

*Comment.*—A striking feature observed in all these cases was the absence of renal colic following the use of papaverin. Ureteral catheterization is not infrequently followed by rather sharp pain along the course of the ureter and in the kidney area lasting sometimes for a few hours. This often amounts to little more than a feeling of discomfort and soreness. In none of these cases was there any pain whatever following the catheterization and instillation. This was unquestionably due to the analgesic properties of papaverin and its effect locally in overcoming spasms of the ureter. The expulsion of the stones in these cases following the use of papaverin was not attended with the usual attack of colic. After injection all symptoms subsided and did not recur, and the patients were not aware that the stone had left the ureter until it was discovered in the bladder (Case I) or was passed per urethram (Cases II and III).

This suggests further the possible value of papaverin used as an injection after any ureteral catheterization to overcome the spasm of the ureter and the associated pain which is observed in certain cases. It appears to be non-toxic in the dosage employed, hence there would seem to be no objection to its use on that score. The pharmacology of papaverin with reference to its action upon the smooth muscle of the ureter has been studied by Macht (*Journal of Pharmacology and Experimental Therapeutics*, vol. ix, No. 3).

While no conclusions can be drawn from the use of this drug in three cases only, the results here reported appear to justify its further use in similar cases. The results in the first case were so striking and prompt after catheterization and the injection of oil had failed to dislodge the calculus, that no time was lost in the next two cases in employing papaverin without first trying the simple catheterization and oil injections. While these latter measures might have been quite as effective I believe the absence of all pain following the use of papaverin is a desideratum worth considering. I may add that the alkaloid papaverin was obtained at the pharmacy. From this the pharmacist prepared both the sulphate and the hydrochloride and made up a 2 per cent. solution of each. No difference was noted in the action of these two solutions. As the sulphate is much more soluble, and hence its solutions more easily prepared, this is recommended for use.

of soreness persisted in the left kidney area. Red cells and leucocytes were present in the urine. A few days later cystoscopy showed a normal right ureteral opening. The left ureteral papilla was swollen, œdematous and puffy. There was a definite area of hyperæmia surrounding the left ostium, the lips of which were œdematous and pouting. The contrast between the two sides was most striking and suggested a lesion low down in the left ureter. A wax-tipped catheter was passed, meeting an obstruction 2.5 cm. above the bladder opening. Beautiful scratch marks were obtained. A large catheter was then passed, and 5 c.c. of papaverin hydrochloride instilled. The catheter was left in place for a minute or two after instilling the drug to prevent it from escaping. It is to be noted that no pain whatever was felt after ureteral catheterization and injection. During the next ten days there was no recurrence of pain, but he felt a slight burning on urination and at times a sudden stoppage of the stream during urination. Cystoscopy at this time showed a small fragment of stone projecting from the ureteral opening and imbedded in the œdematous mucosa. This was dislodged by a ureter catheter and recovered in the bladder washings. Papaverin sulphate was again instilled into the ureter and the patient told to carefully strain the urine. The following day he produced the stone, a rough uric acid calculus the size of a small pea. A subsequent X-ray plate shows the urinary tract free from shadows.

CASE III.—A young man, aged thirty-three years, was first seen in October, 1916, complaining of a deep, severe pain in the left kidney area coming on a few days before. He has never had a similar attack. This one lasted nearly all day and passed off very suddenly. Since the attack he had had continual soreness and discomfort in the kidney region. Abdominal palpation was negative. The urine was clear, but a centrifuged specimen showed a few red cells and leucocytes. X-ray examination showed a shadow in the left kidney pelvis. The apparent size of the stone suggested the possibility that it might enter the ureter and pass spontaneously. As the patient could be kept under observation, it was decided to wait for a time, although we had grave doubts of his passing it. Following several sharp attacks another X-ray examination was made in February, 1917, which showed the stone shadow low down in the pelvic ureter. At this time dull pain and soreness in the back was more or less constant and demanded relief. Cystoscopy showed a normal right ureteral orifice. The left papilla was greatly swollen, œdematous, standing out prominently with an unusually broad surface. In the centre the ureteral orifice appeared as a round hole. This orifice would open with each ureteral contraction and then contract, but never completely close. A No. 6 catheter was passed 3 cm., and

could be the cause of urinary obstruction, (2) when the patient's symptoms are suggestive of a foreign body, tumor, diverticulum, or unilateral renal complication, and (3) when the Röntgen ray shows shadows of a questionable nature. When the Röntgen shadow is definitely the shadow of a large stone there is no need of cystoscopy to corroborate it.

When a cystoscopic examination is indicated in the presence of a large gland it is well to use a cystoscope of small caliber. Such an instrument should be used more frequently in routine cystoscopy of conditions other than hypertrophy. Many urethras are too small to permit of the passage of standard-sized cystoscopes without injury. A cystoscope of large caliber will frequently cause considerable bleeding and laceration of the urethra and its use is often followed by severe forms of urethritis and prostatitis. I have observed several cases in which a stricture of the urethra followed cystoscopic injury. Although a cystoscope of small caliber usually permits only single ureteral catheterization, nevertheless a fairly complete examination can be made. When, on attempting cystoscopy, intolerable pain is caused, it is unwise to endeavor to complete the examination at one time. If the bladder is catheterized and irrigated daily over a period of ten days or two weeks, it is surprising how much more tolerant the patient becomes to instrumentation.

Severe reaction is occasionally seen following simple catheterization of the ureters. I have observed several patients who have been in bed as long as several weeks with chills and fever following simple catheterization of a kidney previously normal. Only recently, in a case in which a ureteral catheter was introduced into the pelvis of a supposedly well kidney (the other one being destroyed) and allowed to remain in the ureter for fifteen minutes while a differential functional test was made, there was subsequent acute exacerbation of a mild chronic pyelonephritis, uræmia and death. Although it is true that in a vast majority of cases there is no danger in renal catheterization, I have repeatedly observed instances in which an infection occurred in the previously healthy kidney following catheterization when infection was present in the other kidney. When it is apparent that the patient's symptoms are caused by lesions in the bladder or urethra it is not always necessary to catheterize both kidneys. When it is apparent that there is a unilateral surgical kidney it is often unnecessary to catheterize the other kidney. However, should there be any doubt as to the functional value of the other kidney and catheterization is necessary to ascertain this, the procedure is justified. Occasionally catheterization

# RECENT OBSERVATIONS IN CYSTOSCOPIC TECHNIC

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WITH the multiplication of various aids to the diagnosis of disease of the urinary tract there has been an increasing tendency to employ one and all of the methods without considering their individual necessity. As a result many unfortunate complications have arisen which could have been obviated if greater care and better judgment had been exercised. The following rule should be adhered to as a guiding principle by every urologist: namely, make no manipulation in the urinary tract other than is necessary in order to complete a diagnosis.

We have grown to regard simple cystoscopy such a commonplace diagnostic procedure that we are apt to employ it when the clinical data are sufficient without it. There should be well-founded indications for cystoscopic examination. In the presence of a negative urinalysis and negative physical examination a cystoscopic examination should not be made merely because the patient complains of a slight degree of bladder irritability. Nor is an occasional pus-cell in the urine a sufficient reason for cystoscopic examination in the absence of other indications, since an occasional pus-cell or red blood-cell is frequently found in a passed specimen of urine when there is no lesion in the upper urinary tract. It is unnecessary to state that the finding of pus-cells in the urine of a female patient is of no value unless the urine is obtained by catheter. Cystoscopy should not be resorted to in order to identify every obscure abdominal pain unless the pain is associated with renal or vesical radiation. Neither is it necessary to resort to cystoscopy to identify every indefinite shadow in the röntgenogram unless supported by clinical indications. There is usually definite contra-indication to any cystoscopic procedure: (1) when the patient is aged and infirm, (2) when the patient is in an emaciated and weakened condition, (3) when there is bilateral renal involvement of extreme degree, and (4) when it is apparent that no surgical procedure would be of benefit.

Routine cystoscopic examination in every case of prostatic hypertrophy is unnecessary and may be followed by grave complications. I have known death to result on several occasions following cystoscopic examination in the presence of a very large prostate. In prostatic hypertrophy cystoscopy should be attempted only (1) when on rectal examination the prostate is so small that it is questionable whether it

acute pyelitis. The microscopic evidence of infection and necrosis is to all appearance the result of irritation and infection ascending from the renal pelvis by way of the tubules. In a series of cases in which we endeavored to remove the injected thorium solution from the pelvis following pyelography, no necrosis resulted. It is advisable, therefore, following the injection of thorium when hydronephrosis is suspected to leave the ureteral catheter in place so as to allow the fluid to drain away. This should be followed by repeated lavage with sterile water until every trace of the medium is removed. Unfortunately, this is not always possible because of retention in the ends of the dilated calyces. Dilatation of the renal pelvis may usually be recognized by other cystoscopic means than pyelography. Recognizing the possible danger resulting from retention of injected mediums, we should endeavor to make the diagnosis of hydronephrosis without resorting to pyelography, and its use should be confined to cases in which other methods of diagnosis leave us in doubt.

Since interference with the drainage of medium injected for pyelography is the cause of resulting damage we have similar problems to meet in the diagnosis of radiographic shadows appearing in the ureteral area. In attempting to identify these shadows, I have on several occasions seen similar evidence of renal infection and cortical abscesses following ureteral pyelography, which could be relieved only by removal of the obstructing stone, and in one case required nephrectomy as well. It is obvious that it is fully as necessary to remove the injected medium completely in cases of stone obstruction as in cases of hydronephrosis.

In the majority of cases in which shadow interpretation is necessary, the evidence obtained by the cystoscope, the ureteral catheter, and the wax tip will suffice. When an impassable obstruction is met with, a shadowgraph catheter will usually be sufficient. However, when there is a suspicious shadow in the original röntgenogram and the catheter meets with little or no obstruction, pyelo-ureterography may be employed to great advantage and is frequently the only method by which an exact diagnosis can be made. Such conditions will permit of thorough drainage and evacuation of the injected medium.

Because of possible retention of the injected medium, it is obvious that simultaneous bilateral pyelography is never justifiable. Furthermore, before a pyelogram is made, we should be reasonably certain that the other kidney is normal. Unilateral pyelography with bilateral lesions, such as nephrolithiasis, polycystic kidney and fused or horseshoe kidney, is attended with greater danger than when the lesions are unilateral and should be attempted only when the indica-

of the normal kidney can be obviated by the simple procedure of catheterizing the diseased kidney and making a differential functional test. The bladder specimen will then represent the functional activity of the non-catheterized kidney.

Considerable trauma and unnecessary pain may be caused by the use of a ureteral catheter of too large caliber. There is usually much less reaction following the use of a catheter of a caliber which permits it to be introduced without meeting much obstruction. The forcing of a large catheter such as a No. 7, or even a No. 6, through a small meatus and up a small ureter with great pressure may be followed by considerable injury. When it is desired only to obtain a specimen from the kidney, a No. 5 catheter will suffice in the majority of instances. It is seldom necessary to use a catheter of larger caliber than No. 6 except in cases of ureteral dilatation.

Pilcher<sup>1</sup> emphatically states that he considers pyelography a very dangerous procedure in the hands of any except the most expert, and that the method should be used only when a definite diagnosis cannot be made by any other means. In my opinion this is a timely warning and should be taken to heart by every one attempting to make a diagnosis of conditions in the urinary tract.

When the value of pyelography as an aid to diagnosis finally became recognized, it was employed generally. It was not long, however, before many cases were reported in which renal complications and even death followed its use. As a result of these dangers the method for diagnosis was in a fair way to be entirely discarded. An attempt was then made to discover some medium which would not cause injury to the kidney. Of the mediums proposed, thorium-nitrate solution had many evident advantages over the others, and it was hoped that a medium for injection had been discovered which would meet all the ideal requirements.

Having used thorium extensively since its introduction almost two years ago, I regret to state that while it has many practical advantages over the other mediums, it may be fully as harmful as colloidal-silver suspensions. When it has been retained in the pelvis of the kidney in hydronephrosis it has occasionally been the cause of diffuse abscesses throughout the cortex similar to those seen with the use of colloidal-silver suspension. The only difference in the resulting lesion is that on microscopic examination no evidences of particles of undissolved silver are visible. The kidney tissue throughout appears markedly irritated and inflamed and the pelvic mucosa shows evidence of

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<sup>1</sup> Pilcher, P. M.: *Practical Cystoscopy*, Philadelphia: Saunders, 1911, p. 157.



My experience with the last-named test, the withdrawal of residual urine, has brought out several points of interest. It is evident that if there are several ounces of retained fluid in a dilated pelvis it may usually be withdrawn through the ureteral catheter by means of a syringe. On several occasions, however, I have noticed an interesting phenomenon, *i.e.*, that similar suction will withdraw several ounces of fluid from a kidney with a pelvis of normal size. This occurs, however, only when there is a condition of excessive hypersecretion. It is necessary that the ureteral catheter should fill the ureteral lumen so that suction with the syringe establishes a lower intra-ureteral pressure. It would appear that the process is one of glomerular filtration and is dependent on the difference in intrarenal pressure. A large amount of fluid withdrawn from a hypersecreting kidney can be differentiated from residual urine by the fact that when a hydronephrosis is present the amount withdrawn can be injected back into the kidney pelvis without causing pain, whereas in normal hypersecreting kidneys if an ounce of urine is withdrawn, renal colic will usually be caused by re-injecting 5 or 10 c.c.

In conclusion, I would say that pyelography should not be used when the diagnosis can be made without it. Even though the diagnosis remains in doubt, *pyelography should not be attempted if the patient is old and feeble, or weak and emaciated, or if the condition of the other kidney is not normal.* When clinical conditions are favorable, however, and a pyelogram is made, it is advisable to leave the catheter in the ureter for at least fifteen minutes so that it may drain thoroughly. The pelvis of the kidney should then be irrigated repeatedly with sterile water. The patient should be kept under close observation and if there is evidence of marked pelvic retention the kidney should again be catheterized within twenty-four hours, the ureteral catheter allowed to drain for several hours, and the pelvis again irrigated. If the patient does not recover following this procedure, a nephrectomy should be done without further delay. By a careful selection of cases and the use of all the technical precautions, the percentage of injury will be reduced to a minimum. Pyelography is of too great value to be discarded, for a number of conditions cannot be diagnosed without it. However, it is obvious that the method should not be employed by one who has not had considerable cystoscopic experience and who has not the facilities to observe the patient carefully during and after examination.

tions are urgent. When a horseshoe kidney is suspected, the relative position of the kidney and pelvis can usually be ascertained by means of a shadowgraph catheter. If further complicating pathology is suspected, pyelography can be resorted to later if necessary. Although it has been said, and with truth, that when complications follow pyelography the kidney is usually otherwise surgical, occasionally a moderately diseased kidney suffers such injury following pyelography that nephrectomy is necessary.

Cystopyelography is also not without its dangers, although it is true that none of the bladder medium will gravitate to the kidney unless there is free access through a dilated ureter. In two instances in which the medium had entered the kidney by gravity from the bladder, it was subsequently impossible to drain from the dilated calyces present. As a result, the patients suffered severe reaction, and, after a prolonged convalescence, their renal function was considerably impaired.

The diagnosis of hydronephrosis may be arrived at usually by other means than pyelography: (1) By the determination of residual urine in the pelvis, (2) by over-distention, and (3) by withdrawal of retained fluid through a syringe. When the ureteral catheter has been introduced into the dilated pelvis the retained urine will run out in a continuous stream without peristaltic hesitation. This can usually be quickened and slowed at will by manual pressure over the kidney area. Continuous rapid flow from a ureteral catheter without peristalsis may occur, however, when there is nervous hypersecretion in kidneys otherwise normal. Such hypersecretion is always bilateral and therefore can be differentiated from the unilateral rapid excretion from a dilated renal pelvis.

The well-known over-distention method of Kelly has proved invaluable in the diagnosis of hydronephrosis. Although there has been some dispute as to the capacity of the normal pelvis, it is now generally recognized that when any amount greater than 15 c.c. can be injected without causing pain dilatation is suggested. This does not, however, necessarily signify that the pelvis itself has a capacity of 15 c.c. The injection of 15 or even 20 c.c. of fluid before pain results is possible with an actual pelvic capacity much less, since part of the injected fluid may return along the side of the catheter to variable distances down the ureter. Therefore, the amount injected in such a case represents the capacity of the pelvis and a part of the ureter as well. This may be proved by injecting an opaque fluid; the partial return flow will be evident in the pyelo-ureterogram.

RICHARD FROTHINGHAM O'NEIL

The cases roughly fall into two groups: First, those showing more or less incrustations on the bladder wall alone, and, second, those which show in addition a marked tendency to the formation of phosphatic calculi, recurring rapidly after removal—most of our cases of this type having undergone multiple operations for the removal of calculi.

The following are illustrations of the first group:

CASE I.—Genito-urinary Department, Massachusetts General Hospital. A. E., aged forty-one; single; insurance agent. First seen in Out-Patient Department, June 26, 1915, with the following history: Presenting symptoms, frequent and painful micturition; duration, seven years. Has passed white chalk-like material from bladder and of late the urine has contained blood. At present, micturition day and night at intervals of one-half hour to an hour; intervals never longer than an hour. Three years ago pain in right kidney region, none at present. A previous X-ray said to have been negative for stone. Bladder very irritable. Urine contained blood and clots. Put on oleum santali; urine taken for examination for tubercle bacilli; an X-ray taken showed a curious mottled appearance in region of bladder from which a diagnosis of incrustated bladder was made.

July 7: Has passed 15 phosphatic fragments since last visit. Some obstruction and grating in deep urethra.

July 10: Urine cloudy but not bloody; alkaline. Smear showed a Gram-positive coccus: 20 c.c. emulsion of *Bulgaricus bacilli* put in bladder.

July 13: Urine acid. Patient still passing calculi.

July 29: Came in with fragment stuck in posterior urethra, which was pushed back into bladder. Has been having almost daily treatment with bladder injections of 20 c.c. of emulsion of *Bulgaricus bacilli*. The urine is acid. A urethral stricture has been dilated to No. 26 French, and the bladder holds 4 ounces. A radiograph taken a week ago shows considerable diminution in amount of calcification in bladder region.

August 9: X-ray shows some phleboliths but nothing in bladder region.

August 16: Bladder is not now irritable.

Cystoscopy: Mucous membranes generally roughened but paler than usual. No vessels seen. No calculi seen, but in some places what seem to be adherent mucopus. Right ureter in normal position. Left not made out.

September 2: Urine strongly acid. Patient has received treatment at irregular intervals.

# THE VALUE OF BACILLUS BULGARICUS IN TREATMENT OF COCCUS INFECTIONS OF THE BLADDER

BY RICHARD FROTHINGHAM O'NEIL, M.D.  
OF BOSTON

SINCE Dr. Caulk drew the attention of the Association at the 1914 meeting to the brilliant results obtained in the treatment of incrustated cystitis with an emulsion of the *Bulgaricus* bacillus, we have been considerably interested in following out this treatment in all suitable cases. We think the report of results obtained and our conclusions drawn therefrom may not be without interest.

I shall not take the time to go into the pathogenesis, descriptions of the lesions or symptomatology of the disease, which are all well known and have been fully described; but will give the histories of a few cases, more or less in detail, which we believe well illustrate certain points of importance.

In all cultures of our cases of incrustated cystitis the culture showed a growth of streptococci and staphylococci, *Bacillus proteus* and *Bacillus coli*. Beyond this no attempt was made to plate out any given strain of bacteria. The cultures in our cases after treatment showed, with two exceptions, colon bacilli only.

*Preparation Used.*—In the earlier cases emulsions made from tablets were used. These were not very satisfactory and the tablets examined almost invariably showed a contamination, mostly with cocci and a few various kinds of bacilli. This was proved by cultures on milk and then worked out on other media, a large Gram-positive staphylococcus being most common.

We then used the liquid culture put up in 10 c.c. tubes, which on examination showed pure culture of *Bulgaricus bacilli*. I understand there is now a new tablet on the market said to be reliable, but we have had no experience with it nor have we had any experience with the *Bacillus acidophilis*.

The technic is simply to inject 20 c.c. into the bladder through a catheter after preliminary cleansing irrigations. If the patient is on constant drainage the catheter is plugged or clamped off for a couple of hours. If there is an open suprapubic wound, some attempt is made to hold the edges together for a time at least. The treatment should be given daily to obtain good results, and be accompanied by the administration of acid sodium phosphate. There were no reactions from the injections in any case.



FIG. 2.—Shadows still visible, but mottling much less extensive.



FIG. 1.—Radiograph before treatment. Note the well-marked shadow of the incrusted bladder also the mottled appearance, which is typical.





FIG. 3.—Mottled appearance has disappeared. Only a few phleboliths to be seen, which are visible in the other plates.



other bacilli, probably *Proteus vulgaris*. *Bulgaricus bacilli* put into bladder. R Acid sodium phosphate.

From February 18 to March 29, eight treatments at varying intervals. Urine remained alkaline.

March 29: Entered hospital. Urine has been acid since three days after entrance. Cystoscopy shows fewer incrustations around neck of bladder than at previous examination. With operating cystoscope these were picked off, a few small particles washed out, the rest left to be passed.

April 15: Cystoscopy under ether shows a small incrustation near the vesical neck on the upper right hand side, and a small one on the lower left side. Bladder otherwise normal. These incrustations were on the base of a considerable slough, but were removed with the curette.

April 22: Cystoscopy shows a slough remaining on the left side of vesical neck, but without incrustation except at five o'clock, where there is a very small incrustation.

April 25: Bladder washed out; small particles in wash water apparently corresponding to what was seen at last observation. Urine strongly acid. Instillation of *Bulgaricus bacilli* continued.

This case shows the necessity of constant regular treatment, as no results were obtained until patient was placed in a hospital. She will be kept under observation and it seems reasonable to suppose that she can be kept free of calculi.

CASE IV.—J., male, aged sixty-seven. March 24, 1915, entered Genito-urinary Service of the Massachusetts General Hospital. Urinary symptoms for a long time. Had passed gravel. Incontinence for two years. Bladder very irritable. Urine foul; alkaline. Culture shows staphylococci and streptococci. Cystoscopy, spinal anæsthesia, shows a considerably incrustated bladder and a small, white calculus at base. Litholapaxy.

March 31: Daily treatment with *Bulgaricus bacilli* 20 c.c. liquid culture. Cystoscopy: Bladder irritable but mucosa not reddened. No evidence of incrustation remaining. One or two flakes of adherent mucopus. Urine remained acid while in hospital.

*Summary.*—This is a case of bladder infection of unknown origin associated with alkaline urine and a coccus infection, resulting in calculus formation. Complete cure in a week by litholapaxy and acidulation of the urine by *Bulgaricus bacilli*.

CASE V.—J. Mc., aged seventy-six, female. ——— 29, 1915, entered Genito-urinary Service of the Massachusetts General Hospital. Frequent painful and difficult micturition for eleven years. For last five years in constant pain and has passed gravel; on one occasion acute retention from fragment.

## COCCUS INFECTIONS OF BLADDER

October—: When last seen, practically no treatment for a month. Condition poor; is having chills frequently. Patient has been lost sight of, but at the last visit was evidently failing rapidly from what we supposed to be a bilateral renal tuberculosis. A guinea-pig inoculation from patient's bladder urine was positive. The ureters were never catheterized.

Although highly unsatisfactory from a clinical standpoint, this case is of interest as showing the power of the *Bulgaricus bacillus* to combat the alkalinity of the urine and incrustation formation even in the presence of the underlying infection, which in this case was tuberculosis. This is well demonstrated by the successive X-rays, the cystoscopic examinations and the improvement in the urine while the treatment was being regularly carried out.

CASE II.—C. L. E., aged twenty-nine; married; colored; housewife. Genito-urinary Department, Out-Patient Department, Massachusetts General Hospital. Five years' frequency of micturition and pain in left flank.

April 13: Cystoscopy showed an incrustated cystitis with alkaline urine. Culture showed streptococci. Treatment started with *Bulgaricus bacilli*.

April 25: Cystoscopy. Urine alkaline. Areas of incrustation much less than at previous examination. Both ureters catheterized. Urine from right, acid, with a little blood, no bacteria, albumin s. p. t. (blood?). Urine from left faintly acid, epithelial cells, no tubercle bacilli, streptococci, albumin trace.

May 2: Improving. Treatment continued. This case is still under observation and is of interest because the ureters were catheterized and the reaction from the kidney shown to be acid and faintly acid against the bladder urine being strongly alkaline. There is as yet little improvement in the urinary symptoms, but the incrustations have practically disappeared.

The following cases are illustrative of the type associated with the rapid formation of calculi:

CASE III.—Mrs. G., aged thirty-three. Private case of Dr. H. Cabot. February 16, 1916: Two and one-half years ago, following childbirth, bladder infection. One and one-half years ago, stone in the bladder crushed. One year ago suprapubic cystostomy showed an incrustated bladder. Passing small stones very frequently; always in pain.

*Examination.*—Healthy looking woman. Catheter specimen of urine strongly ammoniacal; cloudy, alkaline, 1024, albumin good trace, sugar 0. Sediment shows pus, many varieties of bacilli, some Gram-negative streptococci and staphylococci, some

April 29: Litholapaxy; local anæsthesia. This case still has residual urine from incomplete prostatectomy. While under observation was in good condition. Urine could be kept acid. All treatment given up and he returned with alkaline urine and calculi.

CASE VII.—S. W., male, aged sixty-three. Genito-urinary Service, Massachusetts General Hospital. July 14, 1915: Bladder trouble for ten years; frequency, with occasional stopping of stream. In 1911 had a "tumor above the prostate gland" removed. Urinary symptoms were not relieved by this operation. Passed several small stones. In 1914 four large stones were removed. In June, 1915, a stone in the bladder was crushed; four days later passed a small stone. Cystoscopy: Bladder much inflamed. Considerable remaining prostatic tissue. A light phosphatic calculus in base of bladder.

July 15, 1915: Litholapaxy. Urine has been alkaline. Treatment with emulsion of *Bulgaricus bacilli*. Urine became strongly acid after forty-eight hours, and remained so during stay in hospital.

In October, 1915, his physician reports that the patient is free from calculus. The urine is acid and is kept so by using *Bulgaricus bacilli* once in three weeks.

March 2, 1916: Cystoscopy, spinal anæsthesia. A very much reddened bladder with a diverticulum in the roof; no stone present. Ureteral catheter passed into diverticulum shows it to be about one inch deep and containing no detritus. Placed on constant drainage.

March 14: Has been quieting down steadily, although urine still shows pus. Has been using bladder irrigations and injections of *Bulgaricus bacilli* ever since last operation for stone.

April, 1916: Readmitted to Massachusetts General Hospital for treatment of urinary symptoms; apparently pericystitis.

*Summary.*—This is a case of prostatic obstruction with a marked tendency to the rapid formation of phosphatic calculi. By constant use of emulsion of *Bulgaricus bacilli* the urine has been kept acid and there has been no calculus formation for over ten months.

In addition to the cases showing definite incrustation and calculi, we have been in the habit of employing the emulsion of *Bulgaricus bacilli* as a routine in all cases where the bladder has been opened and an alkaline urine persists after operation. We have also employed it in the treatment of sloughing and incrustated urinary wounds.

## COCCUS INFECTIONS OF BLADDER

April 15: X-ray shows a shadow in region of bladder, probably stone. Cystoscopy: Bladder mucous membrane red and dirty, with incrustations and a calculus size of sparrow's egg.

April 30: Litholapaxy, spinal anæsthesia. Fragments washed out; put on drainage. Daily treatment with 20 c.c. liquid emulsion of *Bulgaricus bacilli*. Urine acid in twenty-four hours.

August 24: Four months after operation. One month after operation began to have frequency and pain. Two months after operation began to pass small stones and pus. Has had no treatment with *Bulgaricus bacilli* since leaving hospital.

March 9, 1916: Has vesical incrustations and has passed a good deal of calcium detritus. Cystoscopy: No calculus but area of incrustation and a few small phosphatic granules.

March 10: Emulsion of *Bulgaricus bacilli* injected. Urine acid. Feels much more comfortable.

*Summary.*—This case relapsed immediately on the cessation of treatment, and showed immediate improvement on its being resumed.

CASE VI.—S. L., male, aged sixty-eight. July 9, 1913, Genito-urinary Service, Massachusetts General Hospital. Suprapubic prostatectomy.

October 2, 1914: Cystoscopy shows considerable prostatic tissue remaining, two white calculi and a very considerable incrustation of bladder wall. Urine alkaline. Culture shows colon bacilli and large numbers of streptococci and staphylococci.

October 13, 1914: Litholapaxy. Urine alkaline.

October 20: 20 c.c. *Bulgaricus bacilli* injected after residual had been withdrawn. Urine strongly acid next day.

October 26: Daily treatment with *Bulgaricus bacilli*. Cystoscopy shows a small amount of phosphatic detritus adherent about trigone. No evidence of large deposits seen at the time litholapaxy was done. Ureters, which had previously been hidden by incrustations, easily seen. Culture shows *Bulgaricus bacilli* and *colon bacilli*.

October 30: Feels well. No residual. No irritation. Urine hazy acid, many colon bacilli.

November 7: Urine acid. Culture shows colon bacilli and a large coccus.

December 14: Has continued about same. Reporting regularly for treatment; when he omits it the urine becomes alkaline but quickly becomes acid on resuming injections.

April 22, 1916: Two months ago passed a small stone. Urine cloudy and alkaline. Residual 12 ounces. Cystoscopy shows a deep median cleft; considerable prostatic tissue remaining; a small white calculus behind left ureter.

# SARCOMA OF THE BLADDER IN A CHILD

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BLADDER tumors occurring in children are of such rare occurrence that it seems proper to put individual cases on record. The rarity of such growths in relation to other tumors of the bladder is readily shown by large groups of cases.

In 252 cases reported by Albarran, only six occurred in the first decade of life. In the series of 114 cases reported by Judd in 1912 from the Mayo Clinic, there was but one case under ten years of age. This was not a primary vesical tumor, as it was an angioma involving both the rectum and bladder. Gardner in 1915 collected 369 cases of tumor of the bladder from various surgeons for a report on the results of operative procedures in this condition. Only two occurred in children. Of 62 cases from the Massachusetts General Hospital, investigated by O'Neil in 1915 for an article on "Bladder Tumors in the Young," not one occurred in a patient under ten years of age. Of approximately eight hundred cases of bladder tumor included in these various groups, only eight, or one per cent., of the vesical tumors occurred in children.

Forty-one cases in children were collected by Concetti in 1900 from the literature. Steffens in 1905 collected 32 instances, many of the same cases being included in both groups. These series show that nearly 75 per cent. of the bladder tumors in children occur before the fifth year. Munwes in 98 collected cases of sarcoma of the bladder found 15 per cent. in children under ten. As so great a preponderance of the sarcomatous tumors of children were manifest in the very young, he suggested the embryonic origin of these tumors. This view coincides with our conception of the genito-urinary tumors of children. Of the seventeen new-growths of this tract that we have seen on the surgical service at the Children's Hospital in the last eight years, nearly all may be classified as embryomata. They are of the connective-tissue group and have been designated as different types of sarcomata, depending on that particular type of tissue which has preponderated in the sections examined. It seems probable that they may be derived as fetal "résts" from the Wolffian body. The pathological aspects of the new-growth in the case reported below correspond with this type of tumor,

## CONCLUSIONS

From the analysis of these and other cases, we feel justified in drawing the following conclusions:

1. That the incrustations met with in this form of coccus infection, with an alkaline urine, can be more rapidly and permanently removed by the acidulation of the urine by the bacteria than by any other means.

2. That in certain cases where the incrustations are associated with alkaline urine and a marked tendency to the formation of soft phosphatic calculi, their recurrence may, to a considerable extent, be prevented by maintaining a strongly acid urine by this means.

3. That the method may be of value in the treatment and prevention of the incrustations sometimes seen in urinary wounds.

4. That the treatment to be of value must be carried out at regular intervals and will show better results in private practice or when patients are confined in the hospital than when treated in Out-Patient Departments.

5. That the method is of little permanent value where the infection is not confined to the bladder.

6. That the treatment is entirely without any untoward effects.

*Personal History.*—Full term. Normal delivery. No contagious diseases. Always well. Appetite good. Bowels regular.

*Present Illness.*—Six months ago child began "bed wetting." Urine seemed strongly ammoniacal. Three months ago urination became frequent, once every two hours. Began to lose weight and strength. Urination became painful two months ago. Shreds noticed in urine. One month ago large shred passed about two inches in length and three-eighths inch in diameter. Examined by the pathological department of the Harvard Medical School. "The tissue is poorly preserved. It appears, however, to be sarcomatous in nature. It is quite cellular, with a stroma." Urethra was sore for several days after shred was passed. Soon the child began to gain in weight and less difficulty was experienced in urination. Five days ago child became restless and nervous. During that night the attacks of painful urination came on again. Defecation painful. Last night attacks of pain and frequent micturition occurred every half hour. No blood has been seen.

*Physical Examination.*—Well developed and nourished child. General examination negative. Abdomen soft. No masses or tenderness. Genitalia: Vagina slightly inflamed. Urethral orifice is somewhat œdematous and urethral mucous membrane is everted. No discharge.

During observation in the hospital it was noted that the attacks of pain came on just before urination; were severe, lasted four to five minutes, and were followed by complete relief on voiding. In the intervals between urinations the child was absolutely free from pain. The von Pirquet reaction was negative. The white count was 27,000; polymorphonuclear leucocytes, 86 per cent.; large mononuclear leucocytes, 4 per cent.; lymphocytes, 10 per cent. The urine showed microscopic pus and blood. No tubercle bacilli were found.

October 23: Cystoscopy, ether anæsthesia examination revealed a large, lobulated, sessile tumor, arising from the right lateral wall of the bladder, in the region of the right ureter orifice. The orifice, however, could not be seen, as it was hidden by the mushroom type of growth. The surface of the tumor was smooth, not ulcerated, no bleeding areas seen; in some places necrotic. The tumor was thought to be the size of a hen's egg.

*Operation* (October 27).—Ether. Abdomen opened near median line and peritoneal cavity explored. No evidence of metastases found except a small smooth mass  $\frac{7}{8}$  inch in length by  $\frac{1}{2}$  inch in diameter, lying directly in the course of the urachus. Immediate examination of the specimen; diagnosis, "congenital

## SARCOMA OF THE BLADDER IN A CHILD

Tumors of the bladder in children are clinically malignant, as they have a marked tendency to recur. Pathologically as well, they are malignant, as they may invade the deep layers. They do not tend to metastasize. They are usually situated near the neck of the bladder, arising from the mucous or submucous coats of the trigone, or near the ureter orifice. They may be single or multiple, pedunculated or sessile.

The symptoms are those of vesical irritation: Frequency, tenesmus, pain, incontinence or retention. Cystitis develops, and occasionally bits of tumor tissue will be passed in the urine. Unlike the vesical tumors of adults, hæmaturia is rare, as these growths do not tend to ulcerate.

The diagnosis is often difficult. Persistent vesical irritation in the absence of stone or a congenital stricture of the urethra should raise the suspicion of a bladder tumor. Occasionally, an irregularity of the bladder wall may be detected by a searcher. Repeated urinary examinations may reveal tumor elements. Cases are reported in female children, where portions of a pedunculated tumor have prolapsed through the urethra and have appeared at the external meatus. Cystoscopic examination in older boys and in even very young girls is of extreme importance in suspicious cases.

The course is almost invariably fatal. Occlusion of the vesical outlet may cause dilatation of the ureters and consequent pyelonephritis; or the ureteric orifices may become involved. The growth may infiltrate adjacent organs, as the prostate, abdominal wall, uterus or vagina, and death follow from exhaustion or cachexia.

To quote from O'Neil from whose article much of the data in the foregoing remarks has been derived, "Vesical tumors in children are a very great rarity. The great majority appear before the fifth year. They are of the connective-tissue type and are clinically and pathologically malignant except in rare instances. Difficulties in micturition are generally the earliest symptom; in the absence of stricture they should excite suspicion. Straining is common. Early diagnosis and operation offer the only hope of recovery."

The report of the case of bladder tumor in a child that has come under my personal observation is as follows:

L. S., female, three and one-half years old, admitted to the Surgical Service of the Children's Hospital, October 18, 1915.

*Family History.*—Mother suffering with gastric ulcer for last seven years. Father living and well. Only child. No tuberculosis.



Following operation there was a prolonged period of supra-pubic drainage, the sinus finally closing at the end of six weeks. The capacity of the bladder was at first  $1\frac{1}{2}$  to  $\frac{1}{2}$  ounces. In the sixteen months since operation there has been a gradual dilatation, and at present  $4\frac{1}{2}$  ounces are voided at one time. Progress in this direction has been slow, and the child has been urged to void frequently to prevent soiling her clothes. With the coöperation of the parents, proper training of the bladder should produce a marked improvement in this respect. There have been three attacks of pyelitis of mild degree since operation. Cystoscopic examinations have been made at intervals of about every four months, the last examination having been made on February 20, 1917. At that time the child was in excellent general condition. Cystoscopy showed no evidence of recurrence of the tumor.

cyst of the urachus." The abdominal bladder wall was smooth. The peritoneum was closed and the bladder opened anteriorly. The tumor was slightly smaller than a hen's egg. The base was one and one-half inches in diameter. It arose to the outer side of the right ureter orifice which it overhung, but there was a gap of  $\frac{1}{2}$  inch of apparently healthy bladder wall between the base of the tumor and the orifice. Ureteral transplantation, which it had been feared might be necessary, was not done. Excision was not deemed advisable at this time, owing to the duration of the operation, and the bladder was closed with drainage.

The child made a good recovery and the suprapubic drainage gave relief from pain.

*Second Operation* (November 15).—Ether. Incision reopened. Peritoneum stripped back and a transverse incision made downward across the right lateral bladder wall to the tumor. Tumor excised by an incision including all the coats of the bladder and leaving a margin of  $\frac{1}{4}$  inch of healthy tissue around the base of the growth. Posteriorly the tumor had grown upward in close contact with the ureter for about one inch, but seemed well encapsulated. After reconstruction the bladder appeared about 3 inches in length,  $1\frac{1}{2}$  inches in diameter and the lumen would barely admit the index finger.

The *pathological report* from Professor Wolbach of the Harvard Medical School: Frozen section diagnosis; fibrosarcoma. Tumor evidently of slow growth. The prognosis should be favorable, as the growth is sharply defined where attached to the bladder.

The complete pathological report: Gross specimen, roughly spherical tumor of the bladder, 4 cm. in diameter, attached by a base of 2 cm. in diameter to the inner surface of the bladder wall. Projecting externally from the bladder wall is a nodule 1 cm. in diameter, which is continuous with the main tumor mass. The free surface of the tumor is slightly flattened and nodular. Surrounding the base is a narrow zone of bladder wall. Consistency of the tumor is tough and elastic; œdematous in appearance. On palpation harder nodular portions are found. The free surface of the tumor and the nodules projecting from the external surface of the bladder are sharply delimited. The external nodules appear encapsulated. The limits of the tumor in the bladder wall itself are poorly defined.

*Microscopic Examination*.—The tumor as a whole is composed of loose-textured connective tissue. The cells are either large spindle-shaped or have several processes. The intercellular substance is loose, fibrillar material (collagen). Fibroglia fibres are prominent. Throughout the tumor are islands of more cellular arrangement. Occasionally several cells lie in lacunæ, suggesting differentiation into cartilage, but nowhere does the intercellular tissue resemble cartilage matrix. The growth is invading the muscularis of the bladder wall, and must be considered malignant, though mitotic figures are rare. It comes under the general class of embryomas.

also would have been too dangerous, and various cardiac experts who saw him agreed that a major operation would kill him.

We therefore determined to attempt to cause atrophy of the prostate and shrinking of the intravesical lobes by simple means—radium and fulguration—and the history will show that this was remarkably successful. But as the obstruction to urination still persisted, it was finally decided to carry out a “punch-operation” through the urethra to remove the obstructing collar which remained at the prostatic orifice. This was entirely successful—no further catheterization was required and normal urination has been restored—now of eight months’ standing.

Along with this has come a wonderful betterment of his general health, but as the details are important both to surgeons, internists and pathologists, I will give the history of the case in full.

**CASE HISTORY.**—H. M. H. (No. 4413), aged fifty-three, single, admitted June 2, 1915, complaining of frequent and painful urination, and at times incontinence, fluttering of heart, weakness, nausea and vomiting.

*Family History.*—One sister had cancer.

*Past History.*—Scarlet fever, diphtheria and mumps as a child. Measles at the age of thirty years. Pneumonia four years ago. No history of tonsillitis, but for the past five years has had shortness of breath, palpitation and fluttering of the heart on going up stairs and on arising in the morning. No pain and no oedema, but considerable nausea often associated with vomiting. Suffers greatly from dyspepsia and often has severe gastric crises. No history of lues or urethritis.

*Present Illness.*—About five years ago began to have difficulty and frequency of urination. The obstruction has slowly grown worse, and during the past year the frequency of urination has increased greatly and of late there has been occasional incontinence. For four weeks he has suffered considerably with pain in the bladder, strangury, and, during the last two days, with hæmaturia. His general health has been greatly impaired. He has much dyspepsia, stomachic distress, nausea, vomiting, cardiac irregularity, palpitation and loss of weight. At present he voids urine from 2 to 7 times at night and very frequently in the day, often associated with urgency, burning and pain on urination, and hæmaturia. He has never been catheterized.

*Examination.*—The patient is tall, thin, pale and feeble. The chest is symmetrical; percussion note hyperresonant, and breath sounds high pitched and rather harsh. Vocal fremitus normal and no râles present. Heart much enlarged. P. M. I. is seen

# THE USE OF RADIUM AND THE PUNCH OPERATION IN DESPERATE CASES OF ENLARGED PROSTATE

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IN the treatment of cases of prostatic hypertrophy one is frequently confronted with severe complicating conditions which require most careful study and treatment before an operation to cure the obstruction to urination can be carried out. The kidneys are so frequently injured by long standing back pressure that the phthalein test shows in more than 40 per cent. of the cases an impairment requiring drainage for a more or less protracted period and forced water by mouth to restore them to a sufficiently good condition for operation. The heart is also frequently involved as a result of the renal lesions, but both kidneys and heart usually improve rapidly on appropriate preparatory treatment so that perineal prostatectomy can be carried out without danger.

The ordinary valvular lesions and moderately severe myocarditis are usually not sufficient to contra-indicate perineal prostatectomy, though care should be taken both in the preparatory care of the patient and in choice of anæsthetic—which should be ether in such cases. A quick operation and thorough packing of the wound to prevent loss of blood is sufficient to carry them through safely. It is often amazing to see how well they convalesce and in not a few instances the heart is benefited by the removal of a focus of infection in the prostate. Occasionally we meet with very severe cardiac conditions which do not clear up or improve sufficiently under careful hospital treatment to warrant the risk of a serious operation. Such cases usually go unoperated and unrelieved, and it is with the idea of furnishing a new means of curing such cases of urinary obstruction that I am presenting the following case:

The patient arrived at the hospital in desperate condition. An enlarged prostate with 1300 c.c. residual urine had led to great impairment of the kidneys, and severe degeneration of the heart which was in such bad condition that the patient came near death several times during the nine months of treatment which he underwent. It was evident early that a serious operation was out of the question. Anæsthesia

bad, anæsthesia and prostatectomy would surely invite fatal ending. It is therefore decided to try radium, with the hope that atrophy of the prostate and relief of obstruction to urination will result."

June 16, 1915: *First radium treatment*: 1709 mg. screened by lead covered with 3 inches of gauze and rubber tissue, applied over the perineum. Treatment carried out by Dr. Burnam for eight hours.

June 17, 1915: Patient somewhat exhausted. Pulse a little better. Blood urea improved, now .348 gm. per litre (drop from .576). Phthalein 21 per cent. for two hours.

June 19, 1915: Fulguration applied to middle lobe through cystoscope.

June 26, 1915: Retention still complete. Second fulguration.

June 27, 1915: Phthalein test: appearance time, twenty-six minutes, first hour, 5 per cent., second hour, 10 per cent, total for two hours, 15 per cent. Blood urea, .35.

July 3, 1915: Cystoscopy: The median and posterolateral portions of the prostate are distinctly smaller and are covered with a grayish slough. The left posterolateral portion is more prominent and is fulgurated to-day for five minutes.

July 4, 1915: Retention still complete. Fourth fulguration (median lobe).

July 5, 1915: *Second radium treatment*: 1709 mg. screened as before, applied over lower end of sacrum five hours, over suprapubic region five hours.

July 13, 1915: Retention still complete. Fifth fulguration of prostate.

July 20, 1915: The patient has been wearing a retention catheter up to this time. Retention still complete. General condition, especially heart, greatly improved. Phthalein test shows steady improvement since primary drop after insertion of catheter; is now: appearance time, thirteen minutes, first hour, 14 per cent., second hour, 19 per cent., total, 33 per cent. Blood urea, 0.36.

Rectal examination: The prostate is distinctly smaller and less rounded.

July 22, 1915: *Intra-urethral applications of radium begun*: 103 mg. screened with a platinum capsule 2mm. thick (26-F. in diam.) inserted with a special instrument (Fig. 1), so that radium lay within the internal sphincter, and against the anterior surface of the median lobe. Duration of treatment forty-five minutes (held in place by adjustable clamp attached to table as shown in Fig. 2).

July 26, 1915: Patient up in chair two days and catheterizing himself. Œdema of legs and scrotum for first time.

## THE USE OF RADIUM AND THE PUNCH OPERATION

11 cm. from M. S. L. in fifth I. S. R. C. D. extends 11.5 cm. to the left and 3.5 cm. to the right of the M. S. L. The sounds are rather clearly heard at apex, but extremely irregular, skipping a beat about every 9 or 10 beats. Many beats do not appear to reach the wrist. Over the base of the heart the sounds are pretty well heard and the A-2 seems to equal P-2 in intensity. Pulses are easily felt and appear synchronous, though many of the beats heard at the apex do not reach the wrist. The tension and volume appear rather low and artery wall is perhaps slightly thickened. Blood-pressure, 128-80.

Abdomen: Full, rather distended, with a high-pitched, tympanitic note throughout. Liver dullness extends from fifth rib to 2 f.b. above the costal margin. Spleen is not felt, liver edge not felt. Kidneys not palpable. No masses nor tenderness.

Genitalia: Negative.

Rectal: The prostate is moderately hypertrophied, rounded, smooth, slightly indurated. Both seminal vesicles are slightly indurated.

Catheter: Residual urine 1300 c.c.

Cystoscopy: Both lateral and median lobes are enlarged. The median lobe is quite prominent and obscures most of the trigone. The bladder is markedly trabeculated, and on the left side the orifices of cellules and diverticula are seen.

Urine: Amber, acid, specific gravity 1010, no sugar, albumin a trace.

Microscopically: Red and white blood-corpuscles and bacilli.

Leucocytosis: 13,600. Phthalein test: appearance time, fifteen minutes; first hour, 12 per cent.; second hour, 15 per cent.; total, 27 per cent. Blood urea: 0.576 gramme per litre.

*Clinical Impression.*—The patient is a weak sick man with bad heart and impaired kidneys, due to great back pressure from enlarged prostate. Much gastro-intestinal disturbance. Needs very careful preliminary treatment, continuous catheter drainage, water in large amounts and cardiac therapy. Operation now absolutely contra-indicated.

*Treatment.*—Rest in bed, continuous catheter drainage, forced water. Digitalis p.r.n.

June 7, 1915: Patient much exhausted, heart weak, greatly troubled with abdominal distention. Phthalein test yesterday showed a marked drop; appearance time forty minutes, first hour, 2 per cent., second hour, 12.5 per cent., total, 14.5 per cent. (drop of 12.5 per cent.).

June 12, 1915: Slightly improved. Now taking digipuratum b. d. until 12 doses are taken. Cardiac condition better.

June 15, 1915: Comment, "Phthalein test not improving, heart

November 30, 1915: During the past month condition has been variable. For the last five days has received digipuratum grs. iii, twice daily. Heart action still quite irregular and rate at apex varies between 80 and 90. Blood-pressure 115/60. Stomach has improved greatly, is gaining in strength. Urinary condition unchanged, still wearing retainer catheter. Phthalein: 24 per cent. in two hours.

December 6, 1915: Pulse has varied between 68 and 80. Digipuratum grs. iii t.i.d. since November 30. To-day put on grs. iii b.d. General condition improved.

December 14, 1915: Heart much better. General condition fair. Pulse 70, beats forceful, all coming through to wrist now.

December 15, 1915: Retention still complete—inlying catheter. Cystoscope shows a small rounded middle (posterior) lobe, a small prominent anterior lobe, no enlargement of lateral lobes. Prostate per rectum flat, very little broader than normal.

December 16, 1915: Second intra-urethral radium treatment: 103 mg. applied for two and one-half hours in 3 positions in front of middle lobe as shown in chart (Fig. 3).

December 27, 1915: Third intra-urethral radium treatment: 103 mg. in thin brass capsule surrounded by rubber catheter (Fig. 4), one hour in deeper portion of prostatic urethra and one hour in anterior portion of prostatic urethra, as shown in chart.

January 17, 1916: Fourth intra-urethral radium treatment, with rubber catheter as before, one hour with radium within internal sphincter.

January 24, 1916: Fifth intra-urethral radium treatment, as before, one and three-quarter hours at vesical orifice, and one hour in anterior half of prostatic urethra.

February 21, 1916: *Résumé*: During the past eight months the patient has had two massive doses (1709 mg. each) of radium applied from the back and front; five intra-urethral treatments with 103 mg. at a position against the middle lobe or within the internal sphincter seven hours, and in the anterior half of the prostatic urethra two hours; five fulgurations to the middle and lateral lobes at the vesical orifice.<sup>1</sup>

As a result the prostate has decreased greatly, but complete retention of urine persists. The kidneys are markedly improved as a result of the catheter drainage, but the cardiac condition, though much improved, is still much too bad to consider any form of prostatectomy under an anæsthetic—the unanimous opinion of consultation of medical and surgical examiners.

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<sup>1</sup>In later cases I have used intrarectal treatments of radium in addition to the intra-urethral, as shown in Figs. 12, 13, and 14.

## THE USE OF RADIUM AND THE PUNCH OPERATION

August 7, 1915: *Résumé*: Patient still has complete retention. Is able to void small amounts, but only after considerable straining. He is using a catheter at four to six hour intervals, removing between 400 and 500 c.c. On rectal examination the prostate is small, flat, soft, and one would not judge from the rectal examination that there was present any hypertrophy whatsoever.

Cystoscopic examination shows the bladder mucous membrane slightly congested, the trabeculations are well marked, particularly posteriorly, and to-day one can see the inter-ureteral muscle which, up to this time, has not been visible. Examination of the vesical orifice shows it slightly irregular, somewhat œdematous. On the right side in the region of the right lateral lobe there is present a well-developed, rounded lobule which evidently projects across the urethra at that point. Posteriorly the edge is small, and there is present only a median bar. On the left side a definite projecting lobe, which was present at previous examination, has apparently almost disappeared and the margin shows nothing but the irregularities which are due to œdema of the mucous membrane.

August 9, 1915: The patient was examined to-day, and the lobe on the right side fulgurated vigorously. Patient is going home this evening, and is to return again in about a month. Phthalein test: appearance time, seventeen minutes, first hour, 14 per cent., second hour, 17 per cent., total two hours, 31 per cent.

October 8, 1915: *Second admission*: Patient has been at home for two months. He has been catheterizing himself 4 to 6 times daily. Retention still complete. Patient very weak and nervous, suffers with frequent nausea and stomachic distress. Cardiac condition has become much worse, now very bad, heart action extremely irregular, pulse 140, irregular in force and rhythm. Apex in sixth interspace 14.5 cm. to left. Area of relative cardiac dulness extends 2.5 cm. to right in fourth interspace, and 15.5 cm. to left in fifth interspace. Sounds at apex cooing in character, second accentuated. No definite murmurs. Chest emphysematous, sonorous râles. Blood-pressure 120-85. Red blood-cells, 4,568,000. Hæmoglobin, 80 per cent. Blood urea, 0.564. Phthalein: appearance time, fifteen minutes, first hour, 12 per cent., second hour, 12 per cent., total, 24 per cent. Urine: cloudy, acid, specific gravity, 1016, albumin a trace, leucocytes, epithelial cells and bacteria.

October 20, 1915: Patient has been very sick, extremely weak, with persistent nausea and vomiting. Heart very irregular and weak. Right radial pulse almost imperceptible to-day. Left radial very irregular in force and rhythm.



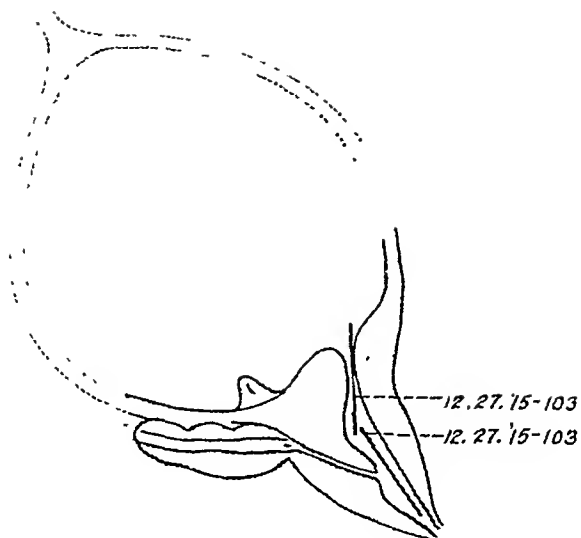


FIG. 4.—Chart showing third radium treatment on December 27, 1915.



FIG. 5.—Showing obstructive bar remaining at neck of bladder after radium treatments.



FIG. 1.—Instrument for introduction of radium in platinum capsule into urethra or rectum.

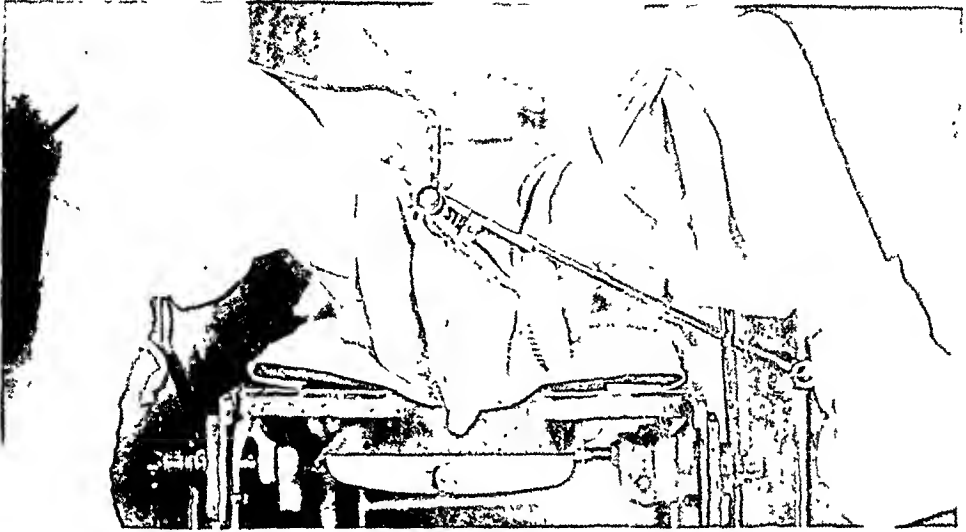


FIG. 2.—Showing retention clamp attached to table holding radium in desired position in urethra or bladder. (In this photograph the tubular radium instrument carrying the cystoscope was employed.)

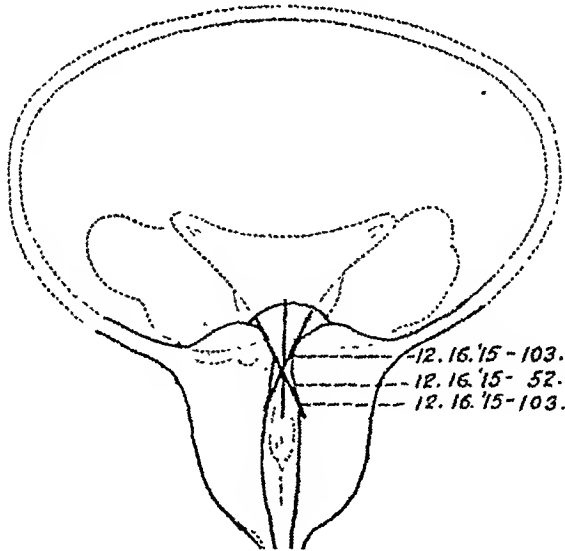


FIG. 3.—Chart showing second radium treatment given December 16, 1915, and milligramme hours in each place.



FIG. 8.—Cutting tube half way through median bar.

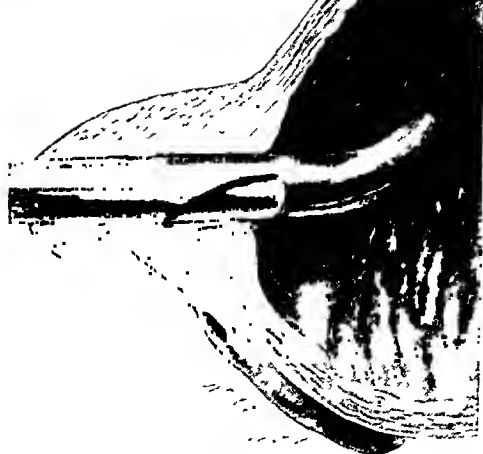


FIG. 9.—Cutting tube pushed home, completely excising bar.

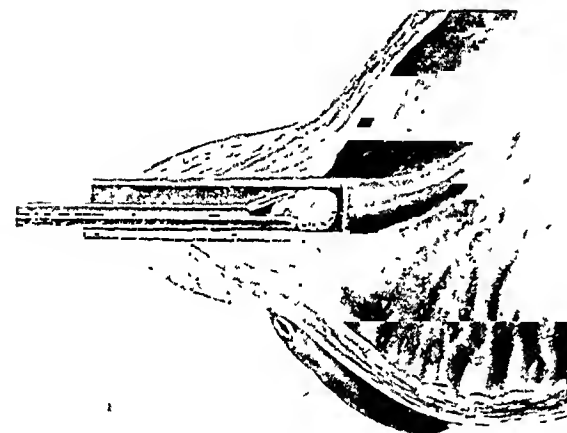


FIG. 10.—The excised bar grasped in tube with intra-urethral forceps previous to removal.



FIG. 11.—Result after excision of bar.

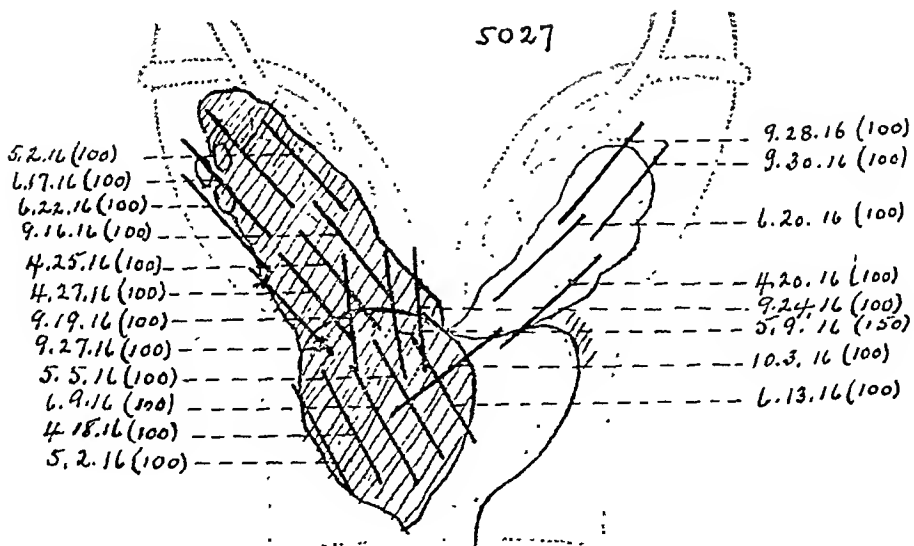


FIG. 12.—Chart of rectal treatments given in a case of carcinoma of the prostate and vesicle.

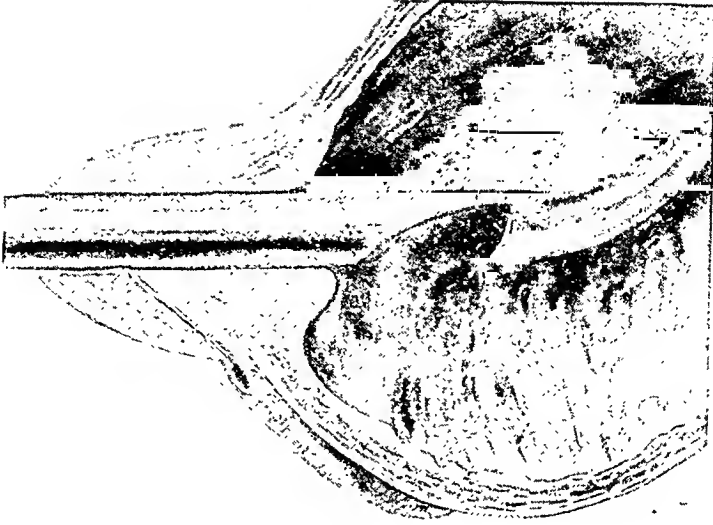


FIG. 6.—Median bar excisor or punch instrument introduced into bladder, cutting inner tube withdrawn allowing fluid to escape, showing that the instrument is in the bladder.

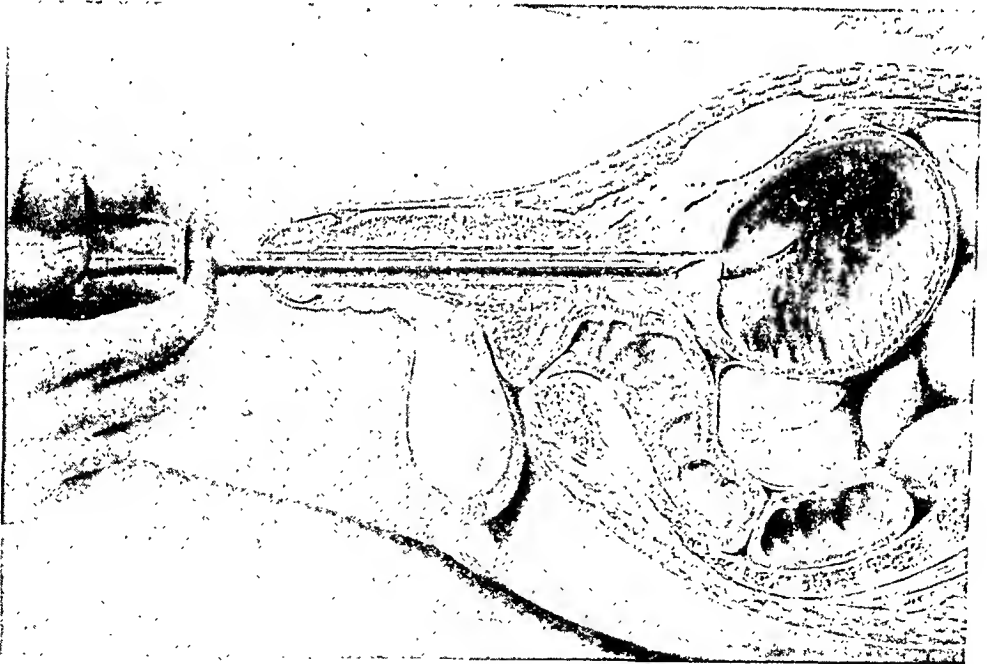


FIG. 7.—Instrument withdrawn until the median bar is entrapped in the fenestra, when the inner cutting tube is quickly pushed inward to excise the bar.



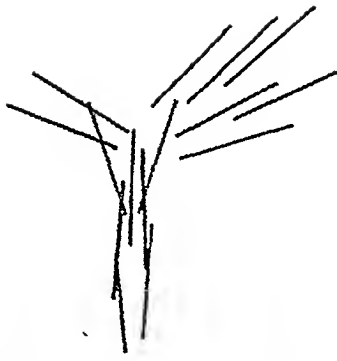


FIG. 13.—Chart showing the transvesical and transurethral treatments given in case illustrated in Fig. 12.

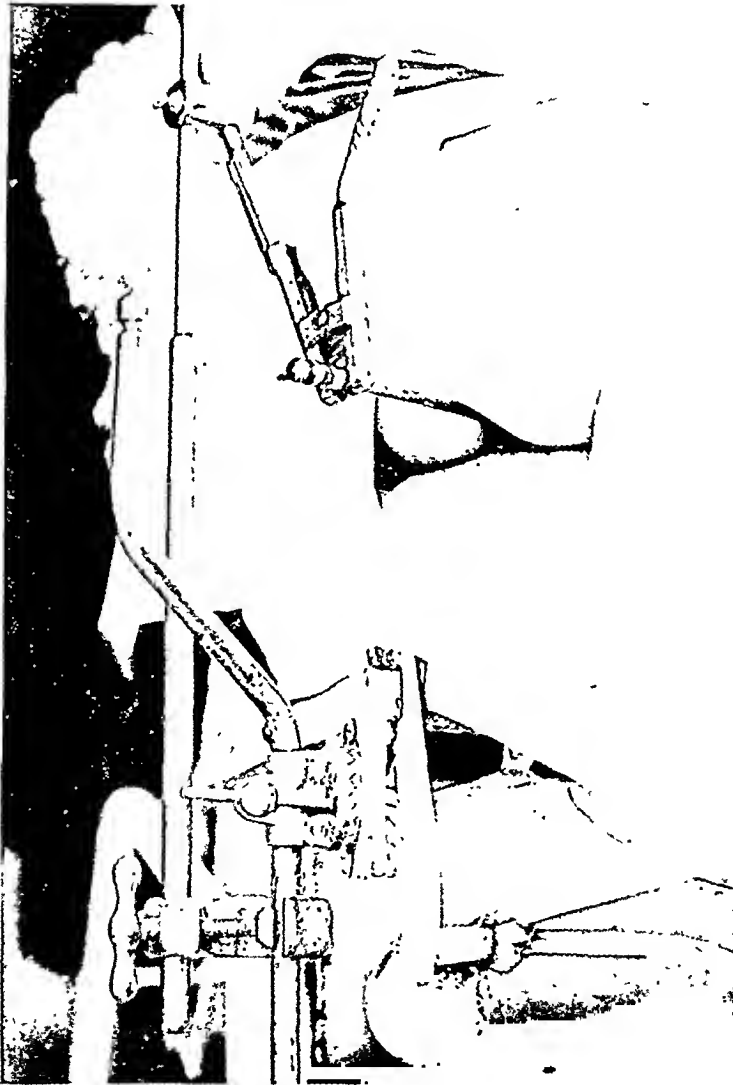


FIG. 14.—Showing rectal treatments, radium held against prostate by retaining clamp. (Patient lying on left side.)

time. Urination normal. Bladder apparently empties itself perfectly. Prostate about normal in size, but slightly indurated. Result excellent.

*Pathological Report.*—By Dr. Howard Cecil. Path. No. 2350. The tissue removed by the anterior cut is 1.2 cm. wide. It contains a small amount of glandular tissue. This section is marked 1. The left anterior cut is 1.5 by  $\frac{3}{4}$  cm. This also contains glandular tissue and the section is marked 2. The left cut is about 0.5 cm. in diameter and this section is marked 3. The left posterior cut is 1.2 cm. by 0.5 cm. wide; it contains glandular structure and is marked 4. The posterior cut is 2 by 1 cm. in diameter; it contains what seem to be definite spheroids and is marked 5. The right posterior cut is 1.5 by 1 cm. and is marked 7. The right anterior cut is 2 by 1 cm., the largest of all of the cuts; it contains a fair amount of glandular tissue and is marked 8.

The entire mass shows a definite hypertrophy, but there does not seem to be such a marked amount of connective tissue, though it is fairly hard.

The sections are very similar in appearance and show the following changes: The tissue is extremely rich in epithelial tissue that has undergone a marked degeneration. The section stains a deep blue with hæmatoxylin. In the acini there are large colloid areas of degeneration. The acini themselves are greatly shrunken, the cells are irregular, generally large, but in places small. The stroma itself has been greatly changed; the cells are vacuolated and the protoplasm has practically all been destroyed. The spheroids here are represented by masses that are very much smaller than normal and definitely encapsulated. There is some epithelial tissue which has undergone a definite colloid change represented by poorly staining blue homogeneous material which, under high power, shows that there is a definite network within the colloid material.

*Remarks.*—The effects obtained by radium in this case have been duplicated now in several other cases at our clinic—a remarkable shrinking of the hypertrophied gland, with the peculiar tissue changes above described—but also without complete relief of obstruction, which generally has remained unchanged, so that radium alone is apparently not a cure for prostatic hypertrophy. The fact that the “punch” operation has been so eminently successful in removing the obstruction remaining after radium treatment at the vesical neck shows a wider use for this procedure which we have heretofore reserved for non-hypertrophic obstructions at the vesical orifice, bars, valves, contractures and congenital obstructions which form so large and troublesome a group of cases.

By means of specially devised instruments, to be used through the rectum, urethra and bladder (Figs. 12-14)—the latter with a cystoscope inside it—it has been possible to get really remarkable results in many cases of prostatic carcinoma—relief of obstruction to urina-

## THE USE OF RADIUM AND THE PUNCH OPERATION

The prostate is found to be about normal in size on rectal examination, and the cystoscope shows that the obstruction present is entirely at the vesical orifice, consisting of a small lobule which is directed anteriorly and to the right, and a fairly broad median lobe—the lateral lobes not being enlarged now. With finger in rectum and cystoscope in urethra the median portion is moderately increased in thickness and there is a firm collar around the shaft of the cystoscope at the vesical neck which is easily palpable.

*Deductions.*—It seems probable that a *punch operation* would remove this obstruction at the vesical orifice and be sufficient to restore normal urination. Plans are accordingly to be made to carry this out.

These were delayed by an acute “cold” accompanied by renewed cardiac disturbance.

*Operation* (March 13, 1916) (Young).—Novocaine 4 per cent. in posterior urethra, opium suppository in rectum, punch operation (Figs. 5–11), 8 cuts in all directions around prostatic orifice, commencing with an anterior cut in which a mass of tissue about 1 cm. in diameter was removed. The tissue masses removed by the lateral and posterior cuts were somewhat smaller, with the exception of the right anterior cut which apparently removed the lobule previously seen in that location with the cystoscope. There was very little hemorrhage—the clots were easily evacuated with a syringe through a large catheter which was fastened in urethra.

March 14, 1916: Patient had very little shock from operation. There was very little post-operative bleeding,<sup>2</sup> and the heart action remained as good as before. *The catheter was removed in thirty hours, and in a short time urine was voided naturally.*

March 15, 1916: No reaction. Voiding urine freely in amounts from 100 to 300 c.c.

March 18, 1916: Continues to improve. Catheter not required. Patient walking about ward.

March 28, 1916: Now two weeks since operation. Convalescence has been remarkably smooth. No cardiac attacks. Has not required catheter since day after operation. *Is now voiding normally, as much as 400 c.c. at a time. General condition excellent. Patient discharged.*

June 15, 1916: Patient returns for observation. He reports continued improvement in every respect. Heart giving very little trouble. Retains urine four hours, voids large amounts each

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<sup>2</sup> I now use a “kephalin” coated catheter and thus induce quick hæmostasis. See paper by H. L. Cecil, *J. A. M. A.*, —, 1917.



## SIDELIGHTS ON PROSTATIC ABSCESS

BY JOSEPH F. MCCARTHY, M.D.

OF NEW YORK

WHILE in the course of their evolution prostatic abscesses, as is well known, manifest themselves in a variety of ways, and although periprostatitis and other purulent processes adjacent to this structure are generally considered under this head, only such purulent conditions as have an integral relation to the gland proper will, in this communication, be considered.

With reference to origin, prostatic abscess is generally classified as intrafollicular or interstitial; with reference to location, as central, cortical or submucous. From the fact of its canalicular relation to the prostatic urethra, as well as the dominant rôle played by the gonococcus, and the frequency of spontaneous intra-urethral evacuation of its pus, it would appear that the principal point of origin of the great majority of such abscesses is not very remote from the deep urethra.

Although in its incipient stage single abscesses may be encountered, the multiple type is habitually the rule. Where apparently one large abscess exists, it commonly is multilocular. Occasionally the whole glandular substance may be destroyed, or a number of small discrete foci may group themselves peri-urethrally, leaving the bulk of the gland intact. When, however, suppurating prostatitis exists and there is formed a large abscess, it nearly always involves the lateral lobes.

The abscess, once formed tends to open externally into the urethra, rectum or perineum. The majority of prostatic abscesses that open spontaneously, do so into the deep urethra (74 in 104 cases). This rupture may occur through a single opening of varying size, through multiple openings, or rupture in an explosive manner, leaving behind cribriform or labyrinthian orifices.

As types of these openings, Fig. 1 represents the punctate type of orifice caused by the spontaneous evacuation of a small submucous abscess, Fig. 2 illustrates the cribriform, and Fig. 3 the labyrinthian type.

On the subject of symptomatology much or little may be said. At first glance it seems rather a trite subject. Unfortunately, such is not the case. A prostatic abscess may divulge its presence promptly, following an antecedent acute Neisserian urethral infection. There is noted a disappearance of urethral discharge, sudden rise in temperature, prostration, lancinating pain, intense dysuria, increased frequency or

tion, disappearance of enlargement, pain and hæmaturia. But the field is too new and the cases too recent to be discussed here. Suffice it to say that in radium we undoubtedly have a therapeutic agent of great value in urology and with improved apparatus, larger amounts of the element (we expect in the future to use 600 mg.) and systematic study of a long series of cases, many brilliant results should be obtainable.

This report serves to show that with radium the hypertrophied prostate may be made to atrophy so that a minor operation will suffice to restore normal urination. The long duration of treatment, however, suggests that it be confined to cases with severe complicating conditions which preclude perineal prostatectomy, although the latter may be ranked as a benign operation, having a mortality now under 2 per cent.



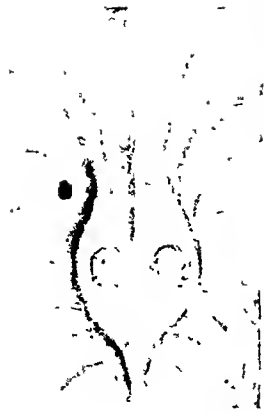


FIG. 1.—Submucous prostatic abscess; spontaneous evacuation through a punctate orifice.

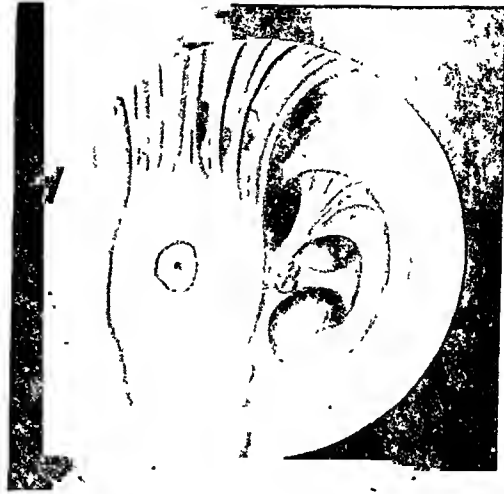


FIG. 2.—Prostatic abscess; cribriform openings.



FIG. 3.—Prostatic abscess; labyrinthian type of openings.

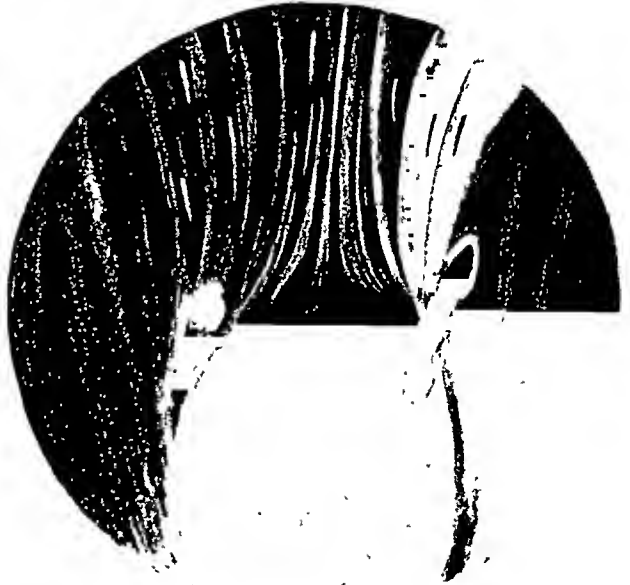


FIG. 4.—Latent submucosal forms of prostatic suppuration. Endoscopic appearance of orifice of discharge.

feature of prostatic abscess. Associate this with the fact that sooner or later prostatic abscesses invade the lateral lobes. Would not this seem to emphasize the importance of intra-urethral lateral lobe encroachment in prostatic hypertrophy, as one of the chief factors in the chronic retention of prostatic enlargement?

As the reader has already noted, the preceding comments on diagnosis deal almost exclusively with the acute forms of the disease—such conditions as manifestly interdict the employment of diagnostic instruments. In the latent or chronic forms of discrete submucosal foci, early instrumental diagnosis, in conjunction with microscopic findings, should be the rule.

In fact with the instruments of precision as now manufactured in this country, in the hands of a reasonably expert instrumenteur, the diagnosis of many of these cases is simplicity itself. Fig. 4 illustrates one type of this class of cases.

On the subject of general prophylaxis and the abortive care of this condition, save for a few relatively unimportant details, there exists much harmony of view. Rest in bed, diet restriction, sedatives, heat to the symphysis and perineum, belladonna and opium suppositories, hot or cold rectal irrigations, etc., constitute the chief remedial agents. In this connection, I cannot subscribe to the use of rigid instruments designed to be introduced into the rectum in the presence of an acutely inflamed prostate. It is unquestionably better to employ two soft rubber tubes for this purpose—a No. 20–24 F. outflow tube provided with a terminal and a lateral eye; a 14 F. inflow tube with a single terminal eye. It should also be distinctly borne in mind that where an enema effect follows such rectal irrigations, the technic is faulty. Nature splints these parts for a definite purpose, which is defeated by three or four daily bowel movements.

When we come to consider the operative care of prostatic abscess, it is rather surprising to note the diversity of opinion as to the correct technical procedure. Practically all seem agreed upon one point—as soon as the diagnosis is made, open and drain. From here, however, surgical opinion radiates in all directions.

The representatives of the French school advocate the exposure of the prostate as in the Proust operation, vertical incision into the gland proper, and the breaking down with the finger of the various pus pockets. They do not advise drainage of the bladder. Others employ a median perineal incision, carried to and into the urethra. The finger is then introduced into this opening and laterally through the prostatic urethra into the abscess cavity. The cavity, as well as the

retention, constipation or painful defecation. Palpation reveals marked intrarectal tumefaction. Its existence may, on the other hand, be ascertained for the first time at the autopsy table. The first case of prostatic abscess that came under my observation occurred during an internship at Bellevue Hospital in 1901. This patient had been operated for urethral stricture, and apparently underwent a normal convalescence. Shortly before his intended departure from the hospital, his chart showed certain temperature excursions. This condition grew worse, and the medical division was requested to go over the case. They diagnosed and treated it as typhoid. Autopsy revealed multiple foci of pus in the prostate gland.

Then there is a silent type of prostatic abscess that is recognized for the first time, somewhat to the astonishment and not a little to the discomfiture of the operator, in the course of a prostatectomy. Still another manifestation of this quiescent form is that described by Alexander. He stated that many cases of uncured posterior urethritis were in reality small discrete abscesses of the prostate. Finally, it has been my experience, and I feel sure that of other urologists with services in large public hospitals, to encounter cases that came to operation for acute or chronic urinary infiltration, as well as for apparent abscess of Cowper's gland, that were in reality old prostatic pus pockets. In many of these cases, there had evidently existed a silent abscess for an indeterminate period.

Though the above comprises merely a few of the manifold aspects of prostatic abscess, it is, I think, sufficient to make out a case for the assertion that the diagnosis of this condition, in many instances, is anything but an easy task.

Rarely is the history of a case as important as in this lesion. It therefore should be gone into most minutely. The reader will not be burdened with these details; they are to be had in any good textbook on the subject. There is, however, a sign-symptom-complex as follows, that may be regarded as pathognomonic. Given a case with an immediately antecedent history of acute Neisserian urethritis, with fairly profuse discharge, there supervenes a complete or almost complete disappearance of discharge, attended with retention, pain usually of a lancinating character, with or without temperature, with or without rigor, but with a large, diffuse, tender tumefaction elicited bimanually; there can be little question as to diagnosis.

In a suspected case of prostatic abscess in young subjects, the sign preëminent is acute retention. In this connection, an interesting corollary is to be noted. Observe that retention is an outstanding

## NON-GONORRHOEAL AND NON-TUBERCULOUS EPIDIDYMITIS

BY IRVIN S. KOLL, M.D.  
OF CHICAGO

THIS type of infection of the epididymis is now being recognized more frequently. Its frequency is much greater than was supposed. The conclusions drawn by the writer are taken from fourteen cases he has encountered in the past two years.

It is extremely difficult to assign a definite etiology to this variety of epididymal infection. In some instances no suggestion of a possible cause can be ascertained.

Trauma in various ways and degrees is evidently the factor most often accountable for the inflammatory and suppurating process that ensues. Direct blow upon the gland, squeezing of the scrotum between the legs when sitting down, were mentioned as causative in two of the cases. Instrumentation for urethral stricture was apparently accountable in three of the cases. In two instances there was direct extension from prostatospermatocystitis. In the remaining seven cases no possible predisposing factor could be determined.

When it is remembered that 20 per cent. of the male urethras harbor from fifteen to thirty different strains of bacteria which, though usually non-pathogenic, may become pathogenic under various stimuli, it is not to be wondered that these bacteria invade the ejaculatory ducts, vas deferens and epididymis.

In the fourteen cases cited, eleven were due to the staphylococcus, one to the streptococcus (Figs. 1 and 2), and two to the colon bacillus (Fig. 3). Thirteen were unilateral, all occurring on the left side; and one bilateral, not simultaneously however, for the right epididymis became involved several days following operation upon the left.

The histopathology, which is all-important in making a definite diagnosis, shows all the changes of a pyogenic infection. Depending upon the virulence of the invading bacteria, the changes vary in intensity and degree. Round-cell infiltration, miliary or large abscess formation, is the picture seen in the acute and subacute cases; marked fibrosis with complete disappearance of the tubules in the chronic type. The associated pathology concerns the testicle. In only one case the infection extended to this organ. This was a very virulent strepto-

bladder, is drained in this operation. Quite recently, in this city, the suprapubic route has been advocated and to some extent practised.

It seems to the writer that next in importance to the evacuation and drainage of the pus, is the conservation of the urethra. If this be true, it follows that the median perineal incision or the suprapubic opening is faulty, the latter particularly so.

It might be asked if 74 in 104 cases opened *via* the urethra—what is the necessity for operation? A sufficient reason is the fact that 27 per cent. of these 74 cases subsequently developed more or less serious complications, possibly from faulty drainage. It, therefore, would appear that all large abscesses of the prostate should be opened surgically *via* the gland proper, regardless as to whether they have or have not opened spontaneously.

The procedure of choice, in the writer's opinion, is to immediately open a prostatic abscess by the perineal route, using the inverted V-incision. When both lobes are suspected make two vertical prostatic incisions deepened until the pus appears. Then, with the utmost gentleness of manipulation, open with the finger the various pockets. When one lobe is definitely involved, incise it thoroughly.

In the majority of cases it is a wise precaution to supplement drainage of the abscess cavity with perineal vesical drainage.

*To summarize:* The keynote of this brief communication is to make clear the fact that in the surgery of prostatic abscess, something more than evacuation of pus is required. A follow-up system will prove conclusively that many of these cases have recrudescences of their old urethritis; that unless they receive the most painstaking after-treatment, they carry foci of infection in the prostate gland that are a menace to the well-being of the individual particularly and to the community in general.



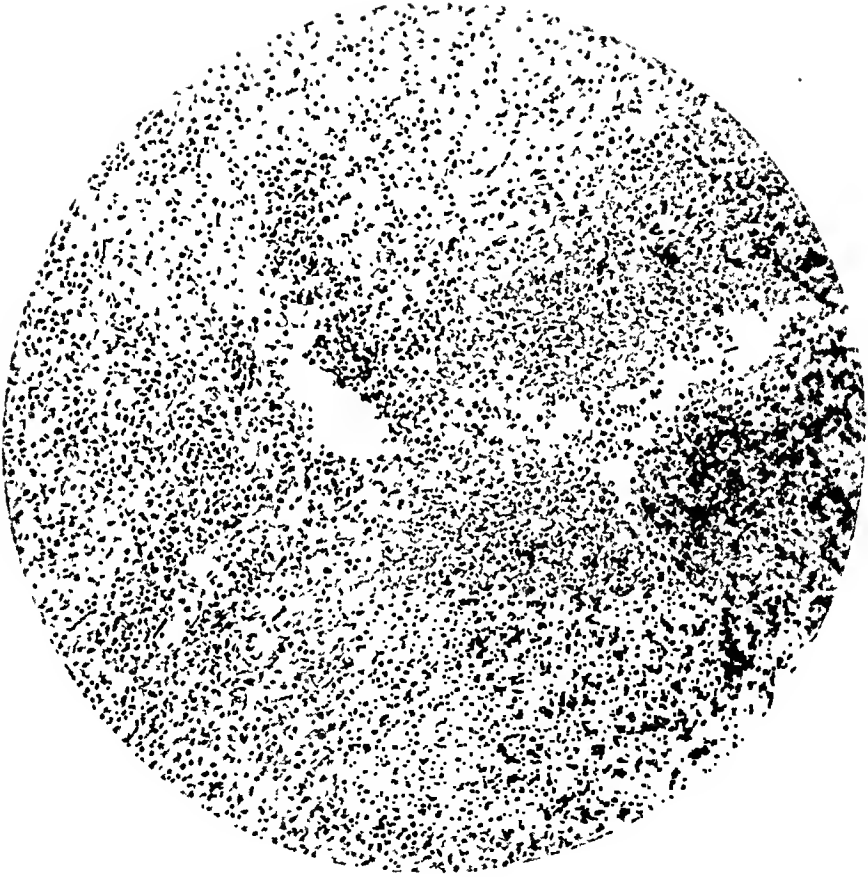


FIG. 2.—Acute staphylococcal epididymitis, showing large abscess.

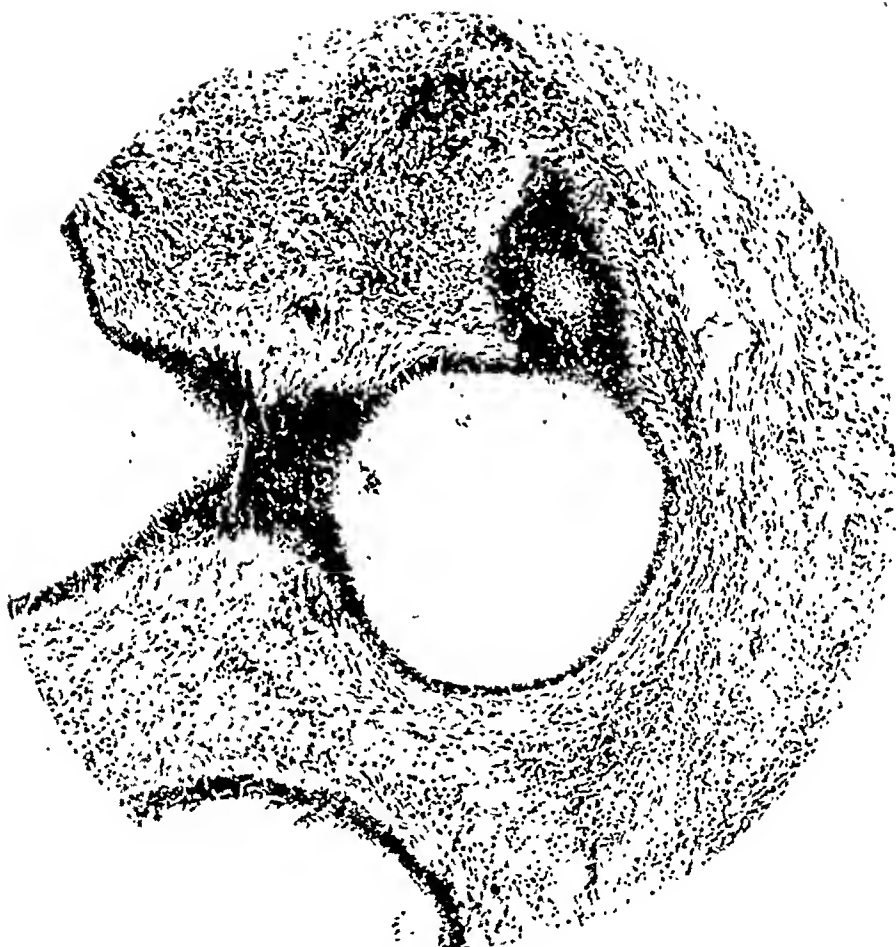


FIG. 1.—Acute streptococcal epididymitis, showing small abscess around a tubule.

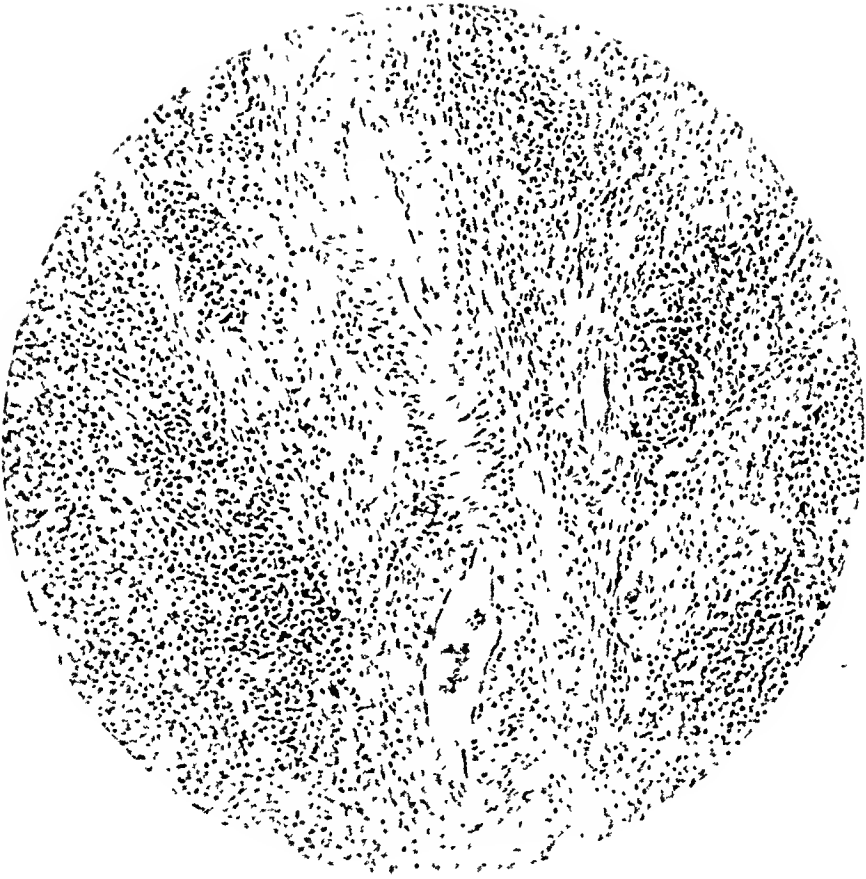


FIG. 4.—Chronic fibrotic epididymitis, clinically identical with tuberculosis of the epididymis.

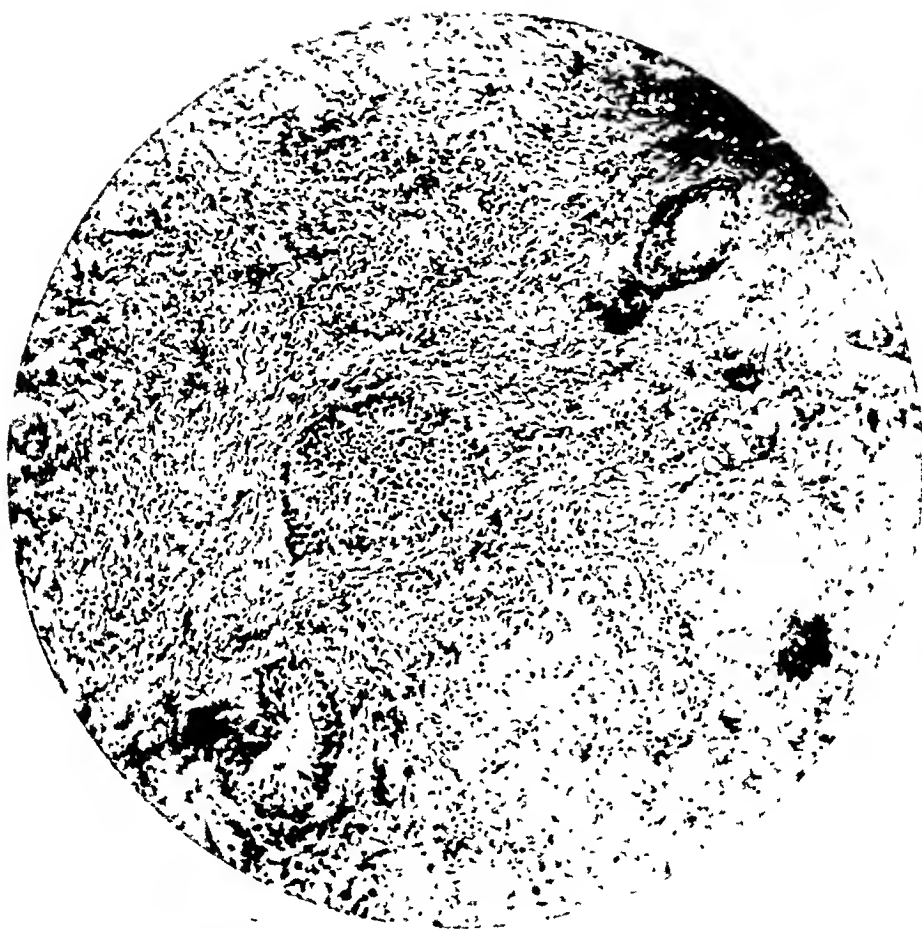


FIG. 3.—Acute colon bacillus epididymitis.

# THE SURGICAL SIGNIFICANCE OF THE ESTIMATION OF THE NON-PROTEIN NITROGENOUS CONSTITUENTS OF BLOOD

WITH ESPECIAL REFERENCE TO THE PHENOLSULPHONEPHTHALEIN TEST:  
A PRELIMINARY REPORT

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THE present contribution is essentially a brief, preliminary note on the comparative usefulness of the newer blood chemical methods in the estimation of *operative risk* from the standpoint of kidney function. The contribution which we shall present before the 1917 meeting of the American Urological Association will give all the data which have been obtained upon a series of urological surgical cases wherein a study of these non-protein nitrogenous constituents was made, together with the figures upon the phthalein output in these cases. Our aim is to show just what these tests will promise to the practical surgeon, *i.e.*, whether they give him any additional information over the routine and special urinary tests, whether they tend to disclose any hidden derangements in the kidney function that the physical examination fails to reveal and whether they finally differ in any particulars from the results obtainable with the Geraghty-Rowntree method of dye injection and elimination.

It might be well to review some of the known facts pertaining to the subject of non-protein nitrogenous metabolism. Without discussing the entire physiological and biological chemical phases of this question, we will content ourselves with a consideration of the chemistry of the three most important constituents, namely, uric acid, urea nitrogen and creatinine. The normal amount of total non-protein nitrogen per 100 c.c. of blood is 5 to 30 grammes; of urea nitrogen 12 to 15, of uric acid 1 to 3.0 and of creatinine 1 to 2.5. Urea comes from food (exogenous) derived from the nitrogenous portions of food, some of which is stored up as amino-acids, others being converted into ammonia and eliminated. Uric acid is partly endogenous and partly exogenous, about half and half. Its derivation from food can be traced from purin, a conversion into xanthin, and, finally, to uric acid, it being diaminoized before change to xanthin takes place. Creatinine is entirely endogenous in origin; it is constant hour by hour in blood and is not increased at all by protein food intake. It is also to be borne in mind that of these

## NON-GONORRHOEAL NON-TUBERCULOUS EPIDIDYMITIS

coccus invasion and also produced marked inflammation of the structures of the spermatic cord.

The clinical picture is either acute, subacute or chronic. The majority of the cases were chronic in their manifestation.

The acute onset is with severe pain along the spermatic cord and testicle. Exquisite tenderness promptly develops, the epididymis swells rapidly and the tunica vaginalis fills with exudate. The scrotum may become oedematous.

Symptoms of sepsis occurred several times. These were chills, temperature as high as 105° F., nausea and vomiting.

The condition may have to be differentiated from torsion of the cord.

The subacute variety is much less pronounced than its symptomatology. There is no systemic reaction. The pain, tenderness and swelling are promptly localized to the epididymis and are much less severe. The chronic type presents the greatest difficulty in diagnosis. Its onset and physical findings so closely resemble tuberculosis of the epididymis that it is utterly impossible to arrive at any final conclusion. To complicate this condition the prostate and the seminal vesicle on the same side may be enlarged and tender.

The treatment is unequivocally radical or operative. In the virulent infection action must be prompt or the testicle will be quickly invaded and destroyed.

There must also not be too much deliberation concerning the subacute and chronic forms for fear that the process may be tuberculous and extension occur. The production of sterility on the affected side must not enter into the consideration. In all probability the vas is no longer patent, and the ultimate results are far too important to delay. Epididymectomy should be promptly performed and histologic examination be made of the removed tissue. Many sections should be examined, preferably the entire epididymis sectioned when there will be no chance of error.

When due consideration is given the import of whether there is any tuberculous process or not the seriousness of the appeal for more care in diagnosing and managing these unusual epididymal infections will be realized.

kidney efficiency or deficiency which goes with a complete blood chemical analysis. The work of Folin, Fitz, Frothingham and Denis, on "The Relation Between Non-Protein Nitrogen Retention and Phenolsulphonephthalein Excretion in Experimental Uranium Nephritis," gives a very good view of the exact value of each method of investigation from a purely experimental standpoint. These experiments showed that there was a wide difference in the figures of the phthalein test and the blood chemical data; that at the beginning of the nephritis, the phenolsulphonephthalein elimination dropped more rapidly than the accumulation of non-protein nitrogen and urea of the blood. During the course of the disease the height of the nitrogenous accumulation is reached from two to three days later than the lowest level of the phenolsulphonephthalein excretion. Non-protein nitrogen and urea accumulated in the blood and returned to normal gradually, in these rabbits, as recovery of the kidney occurred. These observers maintained that in general these two tests paralleled each other but with this essential difference; the amount of phenolsulphonephthalein excretion showed the kidney function at the moment; the amount of non-protein nitrogen and urea in the blood is rather a measure of an accumulating difference between the amounts of waste nitrogen produced in the metabolism and the amounts eliminated by the kidneys. The time element, the duration of the condition, constitutes therefore a most important factor in the comparison of these two tests. The phthalein test indicates the function for the *moment*, the blood chemical tests indicate the true *grade* of the working power of the kidneys. These experiments upon rabbits represent the earliest definite comparative tests of these two methods. The conclusions of Folin and his collaborators have been well borne out in practice. We know that there are many cases with little or no phthalein excretion that are badly deficient and would show high retention of these non-protein nitrogenous blood constituents; we know also that there are some cases with decreased phthalein output that are functioning quite well, viewed in the light of the non-retention of these ingredients of blood; we also know that there may be a normal phthalein output and a marked retention of the blood constituents.

These three sets of conditions would therefore make us pause in accepting alone the evidences of kidney function from the phthalein test alone. Our personal experiences with a comparison of the two methods have forced us to the conclusion that the estimation of kidney function in so far as it interests the surgeon cannot be intelligently viewed from the standpoint of operative risk without a survey of the

three substances which represent the constituents which have been mainly studied with respect to retention and kidney efficiency, uric acid is the most difficult to eliminate its urea than its creatinine.

Studies upon nephritis, from very early to very advanced cases, have shown that the first substance to be retained is uric acid, next comes urea and finally creatinine. Myers and Chace have called attention to the so-called "stair-case" effect of this gradually increasing retention of the three constituents in the order named, dependent upon the severity of the nephritic process. It is in uræmic nephritis that we see the very highest concentration of these ingredients. It is to be emphasized here that the quantities of these ingredients in blood stand in no relationship at all to the presence of pathologically formed substances in urine such as albumin, casts or *urea*. So far as the last named *urinary* constituent is concerned, there is a very wide variation within physiological limits of the amount of urea present in urine, and therefore it is exceedingly difficult to draw conclusions as to kidney function from quantitative urinary urea estimations alone.

We assume that the cause of the severe symptoms in nephritis is impending or advancing uræmia and that the cause of the uræmia is resident in deficient elimination through kidneys. Whether the ingredients in blood which we are analyzing represent the substances themselves that produce the toxic symptoms or whether they are simply an index of the toxæmia, is of but little importance for the purpose in hand. We believe that we have in an analysis of this kind the surest method of determination by laboratory methods of deficiency in kidney function. Let us discuss for a moment the question of estimation of kidney function by means of the older methods, namely, phloridzin, indigo-carmin, cryoscopy and phenolsulphonephthalein. We are certain that practical surgeons and urologists have tried out all these methods and are willing to agree with us that they have in a large measure been found wanting. The estimation of kidney function by determination of the ease and speed with which a chemical dye can be eliminated through them seems somewhat rash, in theory and in practice. We shall confine our remarks more particularly to the functional test of Geraghty and Rowntree, for of all the color-producing substances that are used in kidney functional tests, it seems to be the most commonly used because of the ease of administration, the harmlessness of the procedure and the rapidity of making the test and obtaining the data required. Within certain limitations it gives a fairly good picture of kidney function, still it manifestly cannot give the observer the same intimate picture of metabolic processes and real



and similar conditions, *no individual who has attained a figure of 5 mgms. or over of creatinine has ever recovered*. We have, therefore, in this one blood constituent a most important prognostic guide and one that should be earnestly investigated in our daily work. In one of our cases we found a very high degree of creatinine retention—over the fatal point—and a normal phthalein output. This case finally died of typical uræmia.

Our data have shown some results which will possibly surprise those who are still inclined to believe that the phthalein test is of service in estimating kidney function. We have some cases with mechanical obstruction to the outflow of urine, candidates for operation, with practically normal concentrations of uric acid, urea nitrogen, creatinine and sugar and yet with very low phthalein outputs. These cases according to our view in no way were in a state of disordered kidney function. We have one record of a case of marked stricture with no discoverable physical signs of kidney change, which showed high concentration of these ingredients, including creatinine, figures pointing to an impending uræmia, even though the clinical condition of the patient at the time of the first blood test was extremely good. Later on, true to the prediction of the blood findings, this patient lapsed into uræmia, and dissolution is now imminent, in fact, the patient will surely die before these records are in print. We will have completed in a short time a study of 50 cases of a surgical nature.

We have found that the results of urine analyses in no way compare in value with those of the blood chemical tests in indicating the status of renal function.

We do not wish to decry, for a moment, the carrying out of routine urinary analyses, nor do we wish to minimize the splendid helpfulness of a good urine analysis: rather, do we say that blood urine investigations should go hand in hand, but that the information obtainable from the blood chemical analysis, being of a different character, representing estimation of *retained* products of metabolism rather than the estimation of pathologically changed ingredients of a fluid such as a search for albumin or sugar in urine implies or the permeability through the kidneys of a dyestuff, gives a far better idea of metabolic changes and furnishes a superior basis for the diagnostic and prognostic valuation of a case to that furnished by the urine analyses. The blood chemical analysis tells us what the blood is storing up, what the kidneys are doing and what they are *not* doing, and also the exact status of nitrogenous and carbohydrate equilibrium. The urine analysis tells us a great deal about the pathology of the kidney function. One might be

## NITROGENOUS CONSTITUENTS OF BLOOD

percentage of these blood constituents as well as the phthalein test. We have records showing extensive changes in kidneys without urinary change; without change in the phthalein output and yet with very definite retention of urea, uric acid and creatinine. We have other data showing that in the presence of a rather low phthalein output, kidney function may be unimpaired so far as retention of the non-protein nitrogenous constituents is concerned. The points which we wish to emphasize from our investigations with blood chemical methods as bearing upon the specialty of urological surgery do not vary much from the conclusions that interest the internists, namely, that the estimation of kidney function after all is entirely a matter of computation of a number of factors and that the phenolsulphonephthalein test occupies a subordinate position, even when positive, and then it is of much more importance than when negative. In other words, as recently pointed out by Beer, "The good excretion of test substances usually means good function. Occasionally hyperfunction, however, may accompany severe diseases and may be very misleading." Foster called attention to the high figures of phthalein output in persons dying with uræmia. Unfortunately, the investigators who have worked with these various methods have failed to make sufficiently searching researches upon all the important blood constituents which we are embracing in our present work. Beer's figures are based upon a comparison between phthalein and indigo-carmin, together with some excellent figures upon total nitrogen and urea nitrogen. He states nothing about uric acid or creatinine determinations, or upon sugar determinations.

We wish to emphasize the necessity of determination of the percentage of uric acid in early interstitial nephritis. As pointed out by Fine, possibly the earliest indication of interstitial nephritis is the retention of uric acid. We know that this retention of uric acid is characteristic of gouty conditions, of course, a retention that is of a permanent nature. Fine called attention to the similarity in the findings in gout and in early chronic interstitial nephritis. As the case progresses in severity, we find the urea nitrogen accumulating and lastly, in the extreme stages, we find an accumulation of creatinine. Creatinine accumulations, therefore, indicate severe kidney derangement of function. The striking fact first called to the attention of the profession by Myers, that a creatinine retention of 5 mgms. or over indicates a probable early fatal termination of the case, deserves special consideration at the hands of a surgical group. In Myers' experience, which we can verify by our own experiences in nephritis

# THE RESULTS OF OPERATIONS FOR TUMORS OF THE BREAST, BENIGN AND MALIGNANT\*

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WITH CRITIQUE ON TECHNIC  
BY LEWIS STEPHEN PILCHER, M.D.

THERE is still so great a degree of pessimism among physicians with regard to the cure of cancerous tumors of the breast, that a continuous scrutiny and frequent report should be made of the results which are secured by present methods of treatment in order that it may be determined to the satisfaction of everyone what definite advancement, if any, has been made in treating these lesions. The frequency of late malignant changes occurring in apparently benign tumors is another question of importance, closely allied with which is that of the later course in cases of such tumors which have been subjected to operative removal. It is with reference to their bearing on these various points that the results obtained during the first five years of work in our private hospital are presented in this paper.

*First*, with reference to the tumors and thickenings of the breast which are classified as chronic mastitis, and not infrequently are regarded as conditions in the precancerous stage, it is to be noted that the line of demarcation between the chronic inflammatory condition and a positive malignant state is so indistinct that no less an authority than MacCarty, of Rochester, Minnesota, makes the following significant statement after a most extensive study of the pathology of cancer of the breast: "Where to draw the line between the hyperplastic changes of chronic cystic mastitis and the pictures which are definitely carcinoma is beyond the writer's present power. There is no sharp line of demarcation. One condition merges into the other." In other words, a man who is accustomed to daily examinations of breast tumors, both before and after operation, including the section under

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\* This paper was completed by its author shortly before he was seized by the illness which terminated in his death on January 4, 1917. It is submitted for publication now both for its intrinsic scientific value, and as an example of the peculiar spirit in which he approached all surgical problems. It was his plan that it should be supplemented by a critical discussion by his father of the technic to be followed in operations for breast cancer, and at his urgent request the pages devoted to that subject were prepared. L. S. P.

## NITROGENOUS CONSTITUENTS OF BLOOD

described as an estimation of the organic changes in the kidneys; the other, the blood chemical analysis, is an estimation of the *minutiæ* of the renal function, from a pathological chemical and a pathological physiological viewpoint.

We must insist in emphatically denying that the estimation of the presence and percentage of albumin in urine and even the finding of casts indicate the condition of the kidney function from a surgical prognostic viewpoint. Kidney disease and kidney function are not synonymous by any means, as pointed out by others and confirmed by us.

In the summing up of the observations made by us of the results of routine and special urine analyses, phthalein test and blood chemical analyses, it can be concluded that the surgeon will be well repaid by utilizing the blood chemical methods in handling his cases, the general as well as urological surgical material being included under this heading. We have learned that the true condition of the renal function *cannot* be elicited by urine analyses alone. We have also learned that the phthalein test in estimating this function is not dependable. First, there may be high elimination of this dye by kidneys that are badly deficient. Second, kidneys may eliminate but little dye and yet their function is not disturbed sufficiently to contradict operative attack. Third, the rôle of the phthalein test is always subordinate to that of the blood chemical tests; therefore, the performance of this test, while interesting and partially corroborative, deserves but scant attention from a diagnostic and prognostic standpoint. It should never be taken at its face value when used alone, nor should it at all interfere with the judgment that is passed upon the operative candidate by the results of blood chemical methods. We are inclined to believe that the day is not far distant when these methods must be used in all operative departments of our hospitals, if we hope, in so far as human hands and minds can do so, to attain that millennium of lowest possible mortality for which surgeons are constantly striving.

With the use of these methods it is believed that many of the mishaps that are commonly ascribed to faults in surgical technic will be found to be due to insufficient knowledge of the manner of action of outwardly appearing intact kidneys and that, moreover, cases that urgently demand operative help will be given it, in spite of the apparently bad risks that they may appear to be, viewed in the light of albumin in urine, casts, low phthalein output—the true status having been obtained by blood chemical estimations.

on without removal of this mass of hyperplastic breast tissue, she would die of cancer of the breast. On the other hand, if the entire breast is removed now, she can be assured of absolute freedom from cancer arising from that source. Basing an opinion on experiences gained in this class of cases, it seems logical *to recommend the removal of the diseased tissue in every case where a surgeon of experience cannot say with reasonable certainty that the case is one of non-progressive cystic or inflammatory induration.*

There are other deformities and lesions occurring within the breast which demand surgical care, about whose diagnosis great clinical difficulties are inevitable. For example, Figs. 4 and 5 are examples of extensive solitary cysts of the breast which have destroyed and replaced the breast tissue down to the fascia, and become attached to it. They are large, partly fixed tumors of the breast, causing marked deformity. Careful preoperative examination will often reveal the character of these tumors, and conservative surgery may be done. But unfortunately this is not always possible. The same is true of the unclassified tumors, encapsulated, and often extensively deforming, which are described as cystic fibro-adenomata and papillary cyst fibro-adenomata (Figs. 6 and 7). Clinically we cannot differentiate many of these tumors in the gross, and histologically the borderline is often most uncertain, so that even the most expert microscopist cannot tell us whether we are dealing with a malignant case or not. These facts justify the opinion of those surgeons who teach that if any case of chronic mastitis is operated upon in a woman over forty years of age, no partial resection of the breast should be done, but the entire breast should be removed. This, in fact, has been our own uniform practice in every case of chronic diffuse cystic mastitis.

Most surgeons can recall cases of suspected malignant growths in various parts of the body for which they have hesitated at first to recommend operation, and which they have consented at the request of the patient *to watch for a time*. Having forgotten the lesion for a while, when it is again brought to their attention, they have found it advanced to such a degree of unquestionable malignancy and diffusion that complete removal is no longer possible. Instances of this kind suggest the wisdom of the rule that exploration should be done in all cases of uncertain character. Such early exploratory operation has justified itself in many cases by bringing to early recognition cases in which malignant changes had already begun, and most surely has saved many a woman from death from cancer. For example, we have the records of two cases in point. Examination in one case revealed

## RESULTS OF OPERATIONS FOR TUMORS OF BREAST

the microscope, cannot tell in a given borderline case whether the disease is actually malignant or not.

If this is true from the standpoint of the microscopist it must be acknowledged that the difficulties which face the clinician are even more difficult, when he is called upon to differentiate between a cystic hyperplasia and an early malignancy. This is often true even when the breast tissue is exposed and gross section studied—for example, Fig. 1 is a diagram of a breast which presented different degrees of cytoplasmia and deformity. The area *A* is hard and diffusely infiltrated. The area *C* is also diseased, but to a much less degree. Our impression on examination of this case is that we are dealing with a condition of chronic cystic degeneration of the breast, which at one point is changing to carcinoma. The breast is removed and the area *A*,

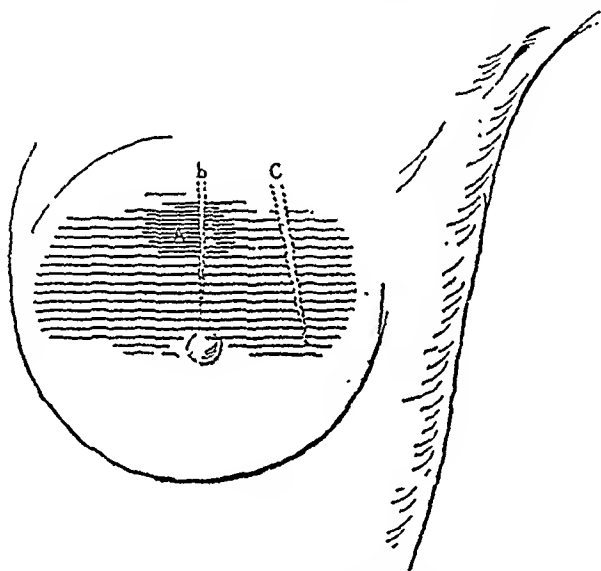


FIG. 1.—Diagram of breast showing areas of induration of indefinite nature with depressed tumor at *A*. Sections made at *b* and *C*.

Fig. 1, is cleared of its fat investment. The picture presented is shown in Fig. 2. Now we find a hard indurated area, with the centre depressed, and surrounded by evidences of advanced cystic hyperplasia. Incision through this area confirms our suspicion of an infiltrated mass extending down to the underlying fascia, Fig. 2, *b*. Then a section is made through the less indurated area at *C*, Fig. 1. This shows the typical gross picture of chronic cystic hyperplasia, as we are accustomed to see it (Fig. 3). In the gross then we have a typical case—first, cystic hyperplasia, and second the incidence of malignant degeneration. And yet the microscopic sections from all parts of this breast fail to show any evidence of tertiary cytoplasmia, *i.e.*, lawless cell proliferation extending beyond the basement membrane. However, we know beyond reasonable doubt that if this patient was allowed to go



FIG. 5.—Section of large hemorrhagic cyst of breast destroying considerable tissue, causing deformity of breast and attached to underlying deep fascia.



FIG. 6.—Life size drawing of dense tumor of right breast in a woman 53 years of age. First noticed a lump six months ago situated in upper quadrant of breast. Freely movable and not in any way attached to the muscle. Glands in axilla and in supraclavicular space not unduly enlarged. Total removal of breast with muscles, dissection of axilla and dissection of supraclavicular space.

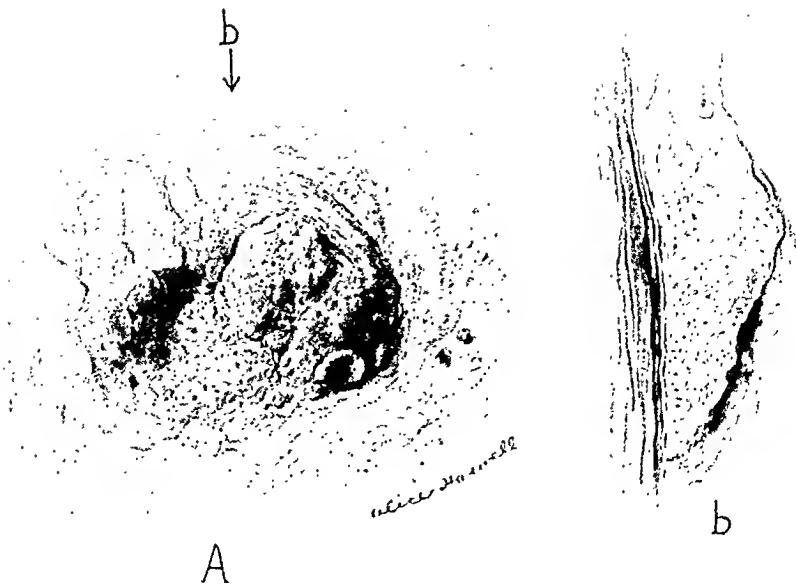


FIG. 2.—Gross appearance of tumor from Fig. 1, A, section made at *b*. Depressed contracted area noted in centre of specimen with evidences of cystic mastitis surrounding evident advanced cystic mastitis in a transitional stage. *b* is a section through indurated mass showing character of change.



FIG. 3.—Section through same breast (Fig. 1) at point C, showing difference in character of gross appearance in same breast. Gross appearance that of an earlier chronic cystic mastitis or primary cytoplasia of breast.

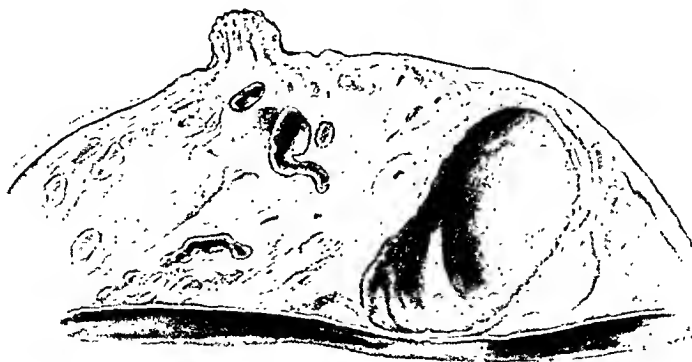


FIG. 4.—Non-malignant cyst of breast causing dense tumor deforming breast attached to underlying fascia easily mistaken for a hard tumor.



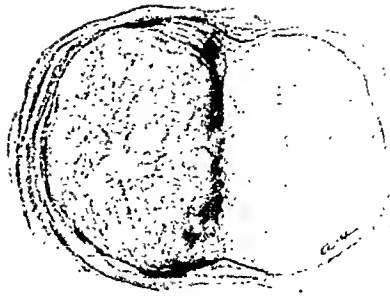


FIG. 10.—Section of encapsulated fibroma of breast.

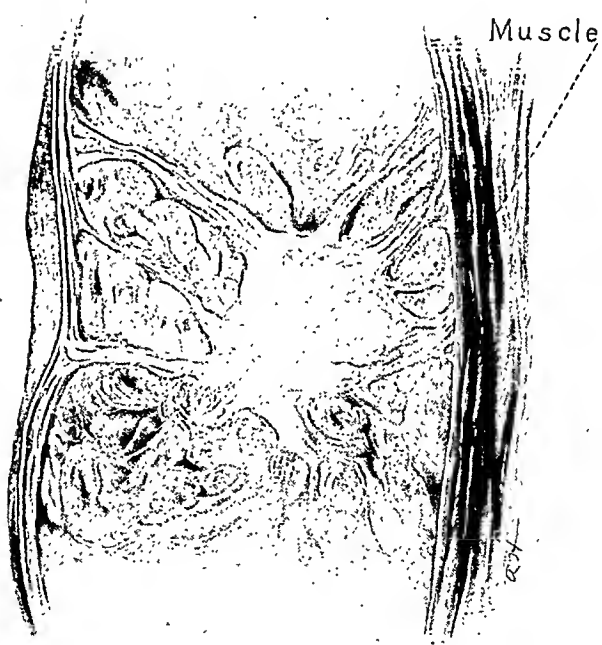


FIG. 11.—Cancer of breast deeply situated within a large breast. Examination showed a small, hard, movable tumor. On removal, under section showed a centrally lying cancer extending along the fascial planes of the skin and to the fascia over the deep muscle, requiring very extensive removal of the fascial planes.

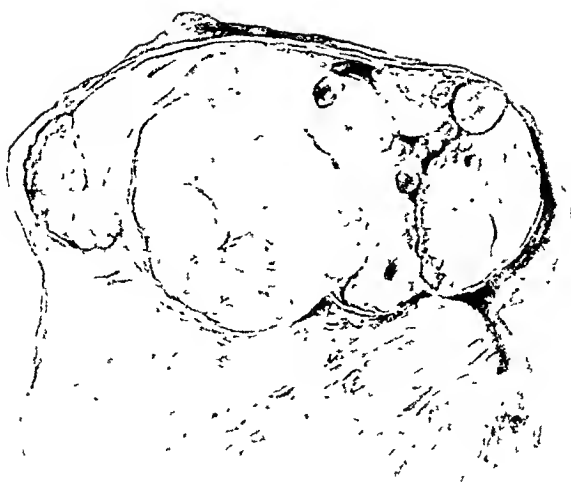


FIG. 7.—Cross-section of tumor seen in Fig. 6. Note, first, the retention cysts in the breast tissue; second, the perfectly encapsulated tumor and contents within the capsule: the various types of tissue—first, in the central portion a dense mass resembling an intracanalicular fibroma, divided from another piece of tissue on the left of the photograph by a fibrous capsule, then a papillomatous-like mass contained beneath the outer capsule, and on the right a series of cysts and one larger cyst which was quite independent of the other two masses.

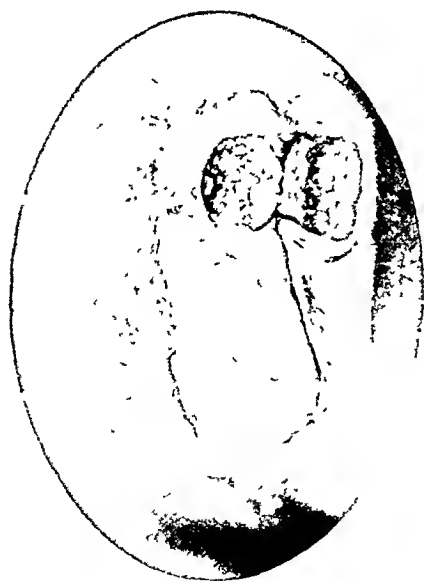


FIG. 8.—Colloid cancer of breast. Small but rapidly spreading to glands. Very malignant.



FIG. 9.—Cancer of lacteal ducts presenting small nodule, retracting nipple. Only symptom continued hemorrhage.

and lymphatic tissues of the axilla were cleaned out. In addition to this, in some the supraclavicular triangle was also opened and freed of any possibly invaded tissue, and in some the fascia leading to the epigastric space was extensively removed. Of these cases all recovered from the operation; eleven are well and free from recurrence to-day; two cases have died of intrathoracic recurrence of the cancer; one patient died of apoplexy without any recurrence of the disease. In five of these cases it is now over five years since the original operation was done. In this class there were 100 per cent. recoveries from the operation with less than 15 per cent. deaths from recurrence.

CLASS III.—*Advanced cancer.* We have operated on eleven other cases all of which were in a very advanced stage of cancer, with extensive axillary involvement, often with supraclavicular extension, in which the operations were undertaken primarily for palliative reasons (Figs. 11, 12 and 13). In four of these cases there was some slight expectation of cure. Of these four cases one has remained well to date, a period of nearly four years. In her case the disease had already invaded both the axilla and the supraclavicular space at the time of operation.

# RÉSUMÉ

Non-malignant Tumors of Breast	Mortality (Operative)	Permanent Cures Per cent.
Fibroma; chronic interstitial mastitis; chronic cystic mastitis; cyst fibro- adenoma (primary and secondary cytoplasmia) .....	14	0
Cancer, early stages .....	14	0
Cancer, advanced stages .....	11	0
		100
		85
		9

Now as to the deductions to be made from such an experience, in which every effort was made to apply with every practicable fulness the precepts of the surgical teaching of to-day, the following statements are justified: In these 39 cases there has been no fatality from operation; every case operated upon in the precancerous stage is well and free from disease to-day; in all of the cases of cancer of the breast operated upon promptly as soon as the disease was discovered, there is an expectation of over 75 per cent. of permanent cures; in the very advanced cases there is only a slight expectation of cure, yet even in these cases many of the deformities and much of the suffering may be relieved by a prompt and extensive operation.

There are certain points in connection with cancer of the breast that cannot be too strongly emphasized and these are:

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a small nodule in the breast which to the fingers felt like a simple cyst, but when removed and sectioned proved to be a small colloid cancer (Fig. 8); a further dissection of the axillary and supraclavicular contents demonstrated the presence of cancer cells in the glands in both of these outlying districts. This patient remains well to date, after a period of over two years. The second case presented a small indurated area below a slightly retracted nipple (Fig. 9); after removal of the breast and axillary gland bearing tissues, the specimen was examined microscopically and proved to be a cancer involving the lacteal ducts. The patient is free from recurrence after a period of more than four years. Such examples could be multiplied in the experience of many surgeons, and they lead us to the conclusion that *more cases which should be operated upon, are refused early operation, on account of the conservatism of the surgeon, than there are cases operated upon by the surgeon in which operation was not required.* That is to say, our mistakes of omission are greater than those of commission.

Now, approaching the subject from this standpoint, we have recently reviewed the cases which have been treated in our private hospital since its opening seven years ago. Although relatively few in number, they have been thoroughly studied, and recorded and followed up. Those under care during the last two years are not included.

CLASS I.—*Non-malignant tumors.* During the first five years, therefore, of the operation of the hospital, fourteen cases of non-malignant tumors of the breast were operated upon. The cases included two fibromata (Fig. 10), one large cyst of the breast (Fig. 4), and eleven cases of secondary cytoplasmia, including under this classification cases of chronic interstitial mastitis, chronic cystic mastitis (Figs. 1, 2, and 3), cystic fibro-adenomata and papillary cyst fibro-adenomata (Figs. 6 and 7), all names descriptive of the predominating pathological condition. In none of these cases could we discover by microscopical examination any actively growing nest of cancer cells. Of these fourteen cases *100 per cent. recovered from the operation, and 100 per cent. are well to-day (1916).*

CLASS II.—*Cancer.* The second class of cases consists of those of unquestioned cancer of the breast, with some axillary gland involvement, but the whole condition apparently still so localized that there seemed a reasonably good expectation of cure. In this class there were also fourteen cases. In all of these cases a complete operation was done, meaning, by the word complete, an operation in which not only the breast itself and the underlying pectoral muscles and a generous area of the overlying skin were removed, but also the fatty

repute, and by many of large experience no permanent cures were claimed.<sup>1</sup>

The change which has taken place in the expectation of benefit from surgical interference in breast cancer, and which is exemplified in the results recorded in the first part of this paper, has been accomplished step by step since Dr. Chas. Moore, of the Middlesex Hospital of London, published, in 1867, his paper on "Inadequate Operations for Cancer."<sup>2</sup>

The importance of the removal of affected axillary lymphatic nodes insisted upon by the earlier writers—Moore, Banks, S. W. Gross—has developed into a complete routine removal *en masse* of the fatty node-containing tissue of the axilla from the apex to the base of this space, for besides the larger lymphatic nodes obvious to the naked eye on dissection, the axillary lymphatics present in their course innumerable tiny nodules of lymphoid tissue, each of which is a perfect lymphatic gland in miniature, and as such likely to be the earliest repository of infective material in transit through the lymphatics from the disease in the breast.<sup>3</sup> The systematic removal in all cases of all the gland-containing tissue of the axilla in an unbroken piece, continuous with the tissue containing the breast itself, is now recognized as a procedure of as much importance as the removal of the breast itself, as a part of the indication to be satisfied in securing the complete removal of the primary focus of the disease.

*The Pectoral Muscle.*—To the researches of a German observer—Heidenhain—published in 1889 (Heidenhain, "Über die Ursachen der lokalen Krebs-recidive nach amputatio mammæ," *Arch. f. klin. Chirg.*, 1889, p. 97) is due the demonstration of the early involvement of the underlying pectoral muscles in cases of cancer of the breast. Not until the publication of the convincing studies of Heidenhain had the full degree to which the carcinomatous process as a rule early extended to the subjacent pectoral muscles been appreciated by surgeons, nor had the importance of the routine removal of these muscles in a piece continuous with the affected breast been recognized. Figs. 11 and

<sup>1</sup> *Vid.* Halsted, *ANNALS OF SURGERY*, 1894, xx, 504; also Sir James Paget, *Lectures on Surgical Pathology*, 3rd Ed., p. 649: "I am not aware of a single clear instance of recovery; of such recovery, that is, as that the patient should live for more than ten years free from the disease, or with the disease stationary."

<sup>2</sup> Chas. Moore on "The Influence of Inadequate Operations on the Theory of Cancer," *Trans. Roy. Med. Chir. Soc.*, 1867, vol. 1, 245.

<sup>3</sup> Stiles, *Contributions to the Surgical Anatomy of the Breast*, Edin. Med. Journ., 1892.

## RESULTS OF OPERATIONS FOR TUMORS OF BREAST

1. *In the early period in the development of every cancer of the breast it is absolutely curable.* If this fact were brought home to every woman, there would no longer be any deaths from cancer of the breast.

2. That, even a large and long active surgical experience does not qualify any man to say positively in many cases of chronic cystic mastitis (secondary cytoplasia) whether there is a malignant element present or not.

3. That in view of the immediate safety and later security from malignancy attending operation in doubtful or borderline cases every such case should have the benefit of surgery.

4. Recognizing the frequency with which the supraclavicular glands are invaded in tumors in the upper quadrants of the breast, every advanced case should have the benefit not only of axillary gland dissection, but also removal of the supraclavicular glands as a part of the primary operation.

5. That cases of recurrence, even where the opposite axilla or other breast becomes involved, are not necessarily fatal, for we have had three cases in which, although it has been necessary to remove both breasts and dissect out the lymphatic tissues from both axilla and both supraclavicular spaces, these patients are well and perfectly healthy to-day, over ten years after the first operation.

## REMARKS UPON TECHNIC

BY LEWIS STEPHEN PILCHER

In planning a technic for the removal of a breast carcinoma one must consider the different elements which have become recognized as essential to permanent success, viz.: (a) Complete removal of the primary focus of disease; (b) avoidance of carcinoma implantation upon the fresh tissue-surfaces exposed by the dissection; (c) the interruption of possible progressive metastasis by the routine removal of the first chain of lymph nodes which receive the absorbents from the area in which the primary focus lies; (d) the use of incisions in the primary steps of the operation that will facilitate the formation of plastic flaps that may be used to cover in the raw area remaining.

### A. COMPLETE REMOVAL OF THE PRIMARY FOCUS OF DISEASE

*The Axillary Lymph-nodes.*—Fifty years ago long-continued immunity from recurrence after an operation for carcinoma of the breast was exceedingly rare in the experience of surgeons even of the greatest



FIG. 14.—Excision of carcinoma of breast and glands of thorax and neck (Same case shown in Fig. 13.) Cervical wound sutured. Raw surface exposed after removal of diseased structures, including both pectoral muscles, to be covered by Thiersch grafts.



FIG. 15.—Carcinoma of breast and of glands of thorax and neck. Primary incision for exposing the structures of the supraclavicular region.



FIG. 12.—Fungating cancer of the breast of long standing, extending down to the muscle fascia.  
Removed for palliative reasons only.



a very natural and proper reluctance will always be felt by a surgeon to remove an unnecessary amount of skin, especially if by so doing he subject the patient to a prolonged period of wound healing. In large tumors with extensively adherent skin, often ulcerated (see Figs. 13 and 14), the freedom with which the skin must be removed in order to carry the line of incision outside the probable area of infection must be so great that all idea of its plastic closure has to be abandoned. Even in such cases it will be found that by free undermining of the skin edges surrounding the raw area, and by raising plastic flaps by suitable outreaching incisions, a very considerable diminution may be secured of what may have seemed at first an appalling area of denudation, so that the amount of skin grafting finally required to cover it in may not be great. Of great importance in its bearing upon the question of the extent of skin removal has been the comparatively recent demonstration of Handley ("Cancer of the Breast and its Operative Treatment," 1906) that the tendency of cancer to spread centrifugally along the skin itself is quite insignificant, but that the important route for its spread is in the lymphatics of the deep fascia, from various points of arrest in which bourgeon outward those growths which involve the skin and form the recognizable nodules; if this teaching is correct, the undermining of the skin boundary and the larger removal of the underlying fascia becomes an important indication to satisfy in any operation. It should not be lost sight of by the surgeon at the time of the operation, especially since it is possible to satisfy it without adding to the difficulties of the later wound-healing. Such wider removal of the fascia will tend to reduce the frequency with which the surgeon, after even extensive skin removals, finds himself later confronted with cancer nodules developing in the skin of his flaps or possibly in still more distant regions (Fig. 15). Here lies also an additional advantage attending the removals *en bloc* of the axillary fat and lymph-nodes and the pectoral muscles, since there is necessarily involved in the dissection a wide extending removal of fascia. The removal of the deep fascia extending downward from the inner lower quadrant of the breast towards the epigastric region can be readily effected through a simple linear incision, by the retraction of the edges of which any desired area of the deep fascia can be exposed and removed without adding any difficulties to the closure of the main wound, but rather with the result of facilitating its accomplishment (Fig. 16). I agree with Handley that the necessary indications for the removal of skin can usually be fulfilled by the removal of a circular area of skin four to five inches in diameter centred upon the

12, made from growths removed at the Pilcher Hospital, show well the manner in which the muscle becomes involved. In the specimen from which Fig. 11 is drawn there is a small carcinomatous nodule situated in the centre of the mammary gland tissue. The diffusion of the process along the connective-tissue strands of the stroma to the muscle beneath is fully apparent, and their connection with the sheath and the substance of the subjacent muscle is unmistakable. In the specimen from which Fig. 12 was drawn the primary carcinomatous focus was more superficial, the skin was early involved and most of the development of the carcinoma has been externally as a fungating mass; the permeation of the carcinomatous process downward to the muscle is none the less evident. No question therefore, in our judgment, can now attend the dictum to include the removal of the pectoral muscles, major and minor, in a continuous piece with the breast as a part of the routine technic in all operations for carcinoma of the breast.

*The Skin.*—If the skin is manifestly involved in the carcinoma, its free ablation with the deeper disease has always been practised. A wider removal of the skin covering a diseased breast was one of the first steps adopted by those surgeons who essayed to make their operation for the breast cancer more thorough (Moore, S. W. Gross). The introduction of methods of covering large raw areas by epidermal strips by Thiersch encouraged surgeons to great liberality in skin removals (Figs. 13 and 14). In most women the possibility of obtaining flaps from the adjacent skin by suitably planned liberating incisions is so great that the covering of very extensive raw surfaces on the front of the thorax by such plastic flaps may be confidently relied upon. Various incisions planned to facilitate the forming of such plastic flaps have been advocated by various surgeons, and will be mentioned in more detail in a subsequent paragraph. It is a surgical maxim that even when the skin is not manifestly involved in a carcinomatous process in a breast, that portion of it which overlies the cancerous focus in the deeper tissue must be regarded with suspicion and practically should always be treated as if it were frankly involved, for it has been demonstrated that invasion of the finer lymphatics of the breast by cancerous elements from a cancerous nodule within its substance occurs early and extends widely, far beyond the manifest infiltrating edge of the primary growth, so whether the overlying skin appears involved in the cancer or not, a sufficient area of it must be removed with the growth to ensure that there be no possibility of any minute cancerous foci in the skin being left behind. On the other hand,

breast. The lymph-nodes for a long time delay the progress of any cancer cells which reach them. Not only do they act as mechanical barriers, but for a time at least they exert a destructive action on cancer cells which reach them, and they only succumb to the invasion after a prolonged resistance (Handley, 52). Even after they have become *frankly infected foci of cancerous proliferation* they are slow to transmit cancer elements beyond their own substance; permeation of the carcinoma into the tissues surrounding them does not take place early, so that any operation which takes the whole chain out of the axilla before the adjacent tissues have become involved may be regarded with much certainty as having gone outside of the area of infection in that direction.

The *supraclavicular nodes* still remain debatable ground. As a rule they become infected much later than do the axillary nodes, and it is not rare for a breast cancer to progress to a fatal termination without any apparent involvement of the nodes above the clavicle. That in a very considerable proportion of cases they do become early infected is indubitable. In our own experience in numbers of instances it has happened to us to have patients present themselves with already manifest gross enlargement of the nodes above the clavicle, and in some instances recurrence after the removal of breast, pectoral muscles and axillary contents has first shown itself in the nodes above the clavicle. It has been demonstrated that the supraclavicular nodes often contain cancerous foci when to the naked eye they appear normal (Halsted). Their deep situation in the neck, covered over by the dense cervical fascia, makes it impossible to detect them by palpation through the skin until they have become materially enlarged by the progress of the carcinomatous process in them, which means at a comparatively late date when further permeation of the carcinoma beyond their borders may have already taken place. If the surgeon waits until they have become large enough to be detected by his finger tip applied to the overlying skin there is therefore greater possibility that the period during which their removal would be definitely efficient to remove all the disease will have passed. If the surgeon opens the base of the neck (Figs. 13 and 17), as he does the axilla, he will fail to find any indication that the supraclavicular nodes are involved in many of them, but on the other hand he will find in occasional instances diseased nodes which otherwise would have escaped detection and would have remained to defeat the most extensive and well carried out operation in other respects. To feel that one has done an unnecessary operation is never agreeable to any surgeon, and such would often be the

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growth, not upon the nipple. Such an area of skin is outlined by an ovoid incision with its narrowest diameter four inches or more, which is carried through the skin and the thin area of areolar fatty tissue just underneath, as the first step in the operation for the removal of a growth in a breast.

### B. AVOIDANCE OF CARCINOMA IMPLANTATION UPON THE FRESH TISSUE SURFACES EXPOSED BY THE DISSECTION

More careful and intelligent attention to prevent cancer material from being sown in the wound while the primary growth is being removed is without question one of the important contributors to the great increase in the proportion of permanent cures that have followed operations for removal of cancer of the breast in recent years. Halsted, of Baltimore, in his epoch-making paper on "Operations for Cure of Cancer of the Breast" (ANNALS OF SURGERY, 1894, xx, 497), stated with emphasis that no incision should ever cut through cancerous tissues if it is possible to avoid doing so, saying: "that the wound might become infected with cancer either by the knife which had passed through diseased tissue, and perhaps carried everywhere the cancer-producing agents, or by the simple liberation of the cancer cells from their alveoli, or from the lymphatic vessels. The division of one lymphatic vessel and the liberation of one cell may be enough to start a new cancer. It is obvious that cancer-cell liberation and implantation may readily occur in the course of the operation when the section unintentionally goes through an unnoticed or unrecognizable minute tenuous proliferation of the disease which may have already extended in this degree to some distance away from the recognizable tumor along fascia or into muscle." The insistence by Halsted that skin and breast and axillary contents and pectoral muscles should be brought away in an unbroken mass was not the least important of the details of the operative technic followed by him, since by such a method only can the dangers of such cell implantation be reduced to a minimum. Since the publication of Halsted's paper in 1894, the removal *en bloc* of all the tissue under suspicion has become the rule among surgeons, and has been followed in all our own work.

C. THE ROUTINE REMOVAL OF THE FIRST CHAIN OF LYMPH-NODES, which receive the absorbents from the area in which the primary focus lies, has already been discussed in connection with the remarks upon the complete removal of the primary focus of disease. The axillary lymph-nodes form the first line of defense against early wide dissemination of the cancer cells taken up by the primary lymph radicles of the

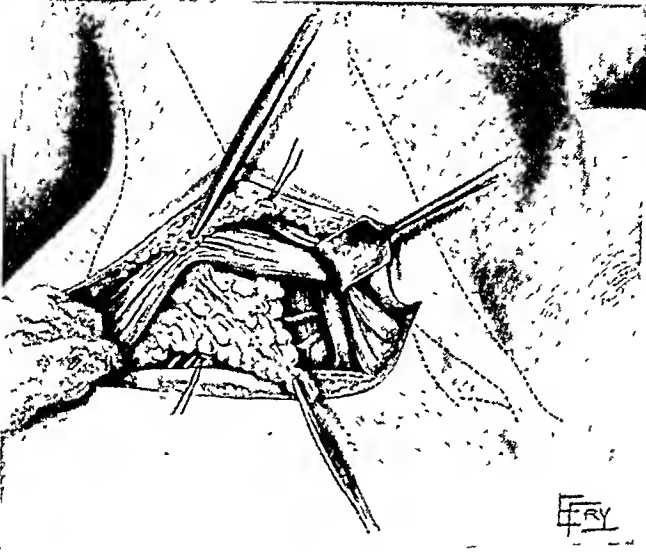


FIG. 17.—Dissection of *supraclavicular* gland-bearing tissue. This is done as the first step of the operation.



FIG. 15.—Recurrence of cancer in skin. Should be removed early.

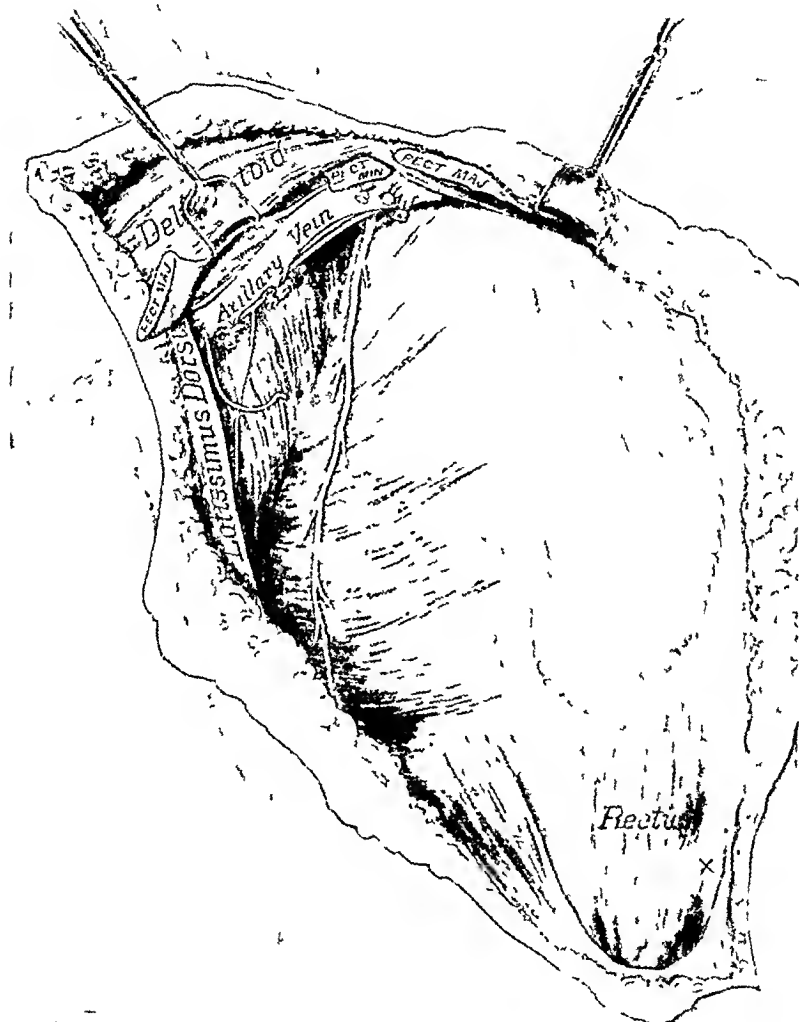


FIG. 16 —Showing the area exposed at the completion of the recommended operation for carcinoma of the breast. The axilla has been cleared; the pectoral muscles with overlying breast have been removed; the fascia covering the upper third of the rectus muscle has been taken off. The cross (X) marks the site of the weak epigastric spot.

first line of defence against carcinomatous permeation equally with the axillary nodes and should be as a routine included in the tissues to be removed in all cases in which the primary focus of the carcinoma is in the middle or inner portions of the upper hemisphere of the breast. In the more advanced cases in which a great part of the whole mass of the breast has become involved, the indication to remove the supraclavicular nodes also develops. The state of the axillary and subclavian nodes is of importance from yet another point of view. The immediate effect of the conversion of a lymph-node into a carcinomatous mass is to block the lymph flow through it and to dam back the lymph and compel it to flow through other channels. Any considerable involvement of the axillary and subclavian nodes would of itself exaggerate the normal pressure upon the channels that lead up over the clavicle on the front of the thorax, and thus increase the possibilities of transfer of carcinoma already in the breast to the supraclavicular nodes direct. Hence the conclusion is logical, and the teaching is important that, whatever the location of the primary tumor, where the axillary and subclavian nodes have become so involved as to manifestly no longer be susceptible of freely transmitting the lymph stream, the supraclavicular nodes should be included in the tissues removed. The longer the duration of the axillary lymph-block, the more imperative the indication for exploring the base of the neck.

These considerations as to the relation of the supraclavicular nodes to the breast have governed us in our own work for many years, and the resulting technic has had its influence in securing the results now reported. The rules that guide us as to invading the supraclavicular space may be formulated as follows:

Regardless of whether or no enlarged nodes may be palpated above the clavicle, the supraclavicular space should be opened and its fat lymphatic tissues removed:

(a) Whenever the superior axillary and the subclavian group of lymph-nodes are infected to a pronounced degree.

(b) Whenever the primary focus of breast infection is in the upper hemisphere of the gland and well advanced in its development.

(c) Whenever the disease in the breast, whatever its primary location, has involved the upper hemisphere, and the growth is judged to be still operable.

*Primary Skin Incisions.*—While the amount of skin to be removed must in all cases comply with the principles already outlined in discussing the indications involved in complete removal of the primary focus, there are other considerations which the surgeon should take

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situation of the surgeon who opens the base of the neck in all cases; but to find in the future history of a case that one has omitted a most important and vital portion of surgical effort, a part which could readily have been done without adding materially to the risks of the operation, must be far more disagreeable.

As a guide to the surgeon in determining whether he shall clear out the supraclavicular space in a given case in which no gross evidence of infected nodes is apparent some help may be derived from a consideration of the paths along which infection may be carried to the supraclavicular nodes. If the more usual course is by permeation

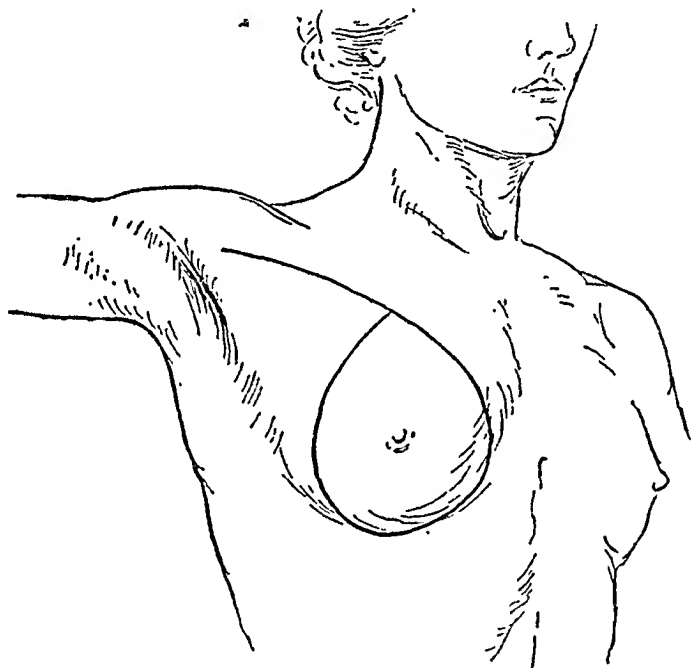


FIG. 18.—The Halsted incision.

along the efferent lymphatics which pass from the axillary to the supraclavicular nodes, then only when the upper nodes of the axillary chain together with the subclavian (Fig. 13) are much affected would one be led to suspect the transmission of infective material to the supraclavicular space. This would be an indication, without regard to the location or extent of the primary disease in the breast, that the supraclavicular space should be cleaned out (Fig. 17). If, however, the demonstration of the anatomists (Cuneo and Poirier) is accepted that there is in many cases, though not invariably, a set of lymphatics which share in the drainage of the upper half of the breast and pass upward in front of the clavicle to the deep-lying supraclavicular nodes, then in such cases these supraclavicular nodes will form a part of the



of the vascular fatty superficial fascia layer is raised with the skin in making these flaps and care is taken to have wide bases of attachment that will supply nutrition to the whole of the flap, which must finally

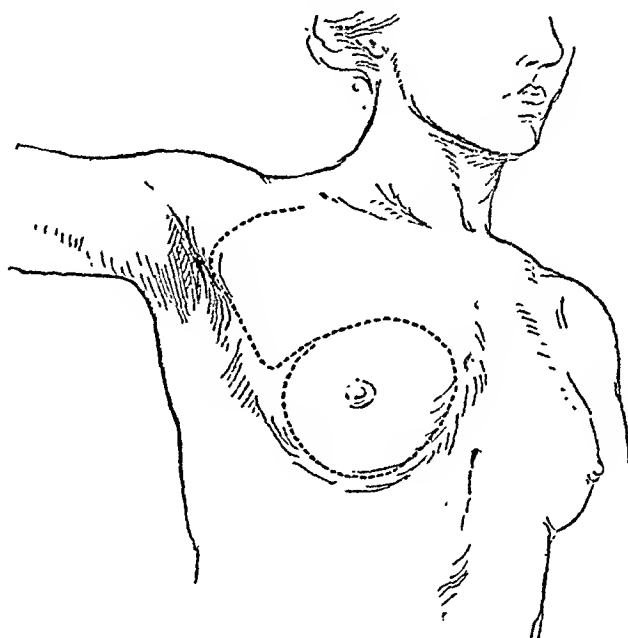


FIG. 20.—The Jackson incision.

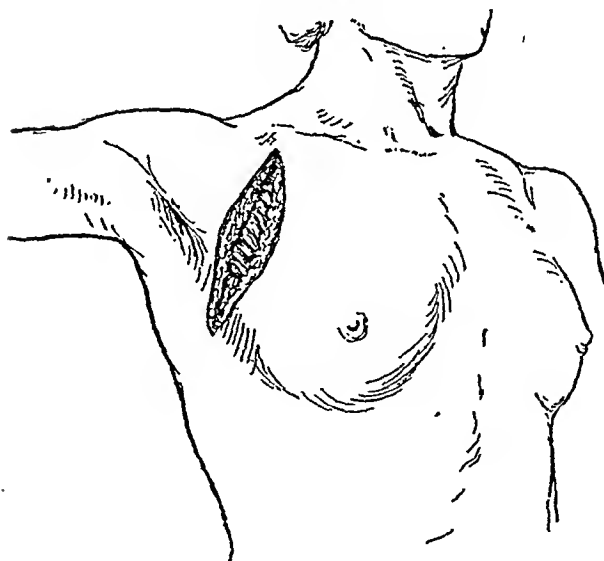


FIG. 21.—The Rodman incision.

not be subjected to too great tension in approximating it to its place for suture. Jackson recommends procuring a flap from the anterior outer portion of the thorax and anterior axillary wall by an incision which is shown in Fig. 20 (Jackson, Reprint). It will be found a

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into account in planning his skin incisions. He has further to consider in each case how he can secure the greatest freedom of access to all the tissues to be removed, and how he may with the most facility obtain the skin required to cover in the extensive raw area left by his dissection. He must not leave any dead spaces for the retention of secretions and he must furnish the axilla with such an adequate covering of skin that the movements of the arm shall not be seriously restricted when healing is completed, and the axillary scar must be in a position not exposed to friction and pressure. The original incision employed by Halsted (*ANNALS OF SURGERY*, 1894, xx, 528) is shown in Fig 18. It was planned to facilitate an operation in which the

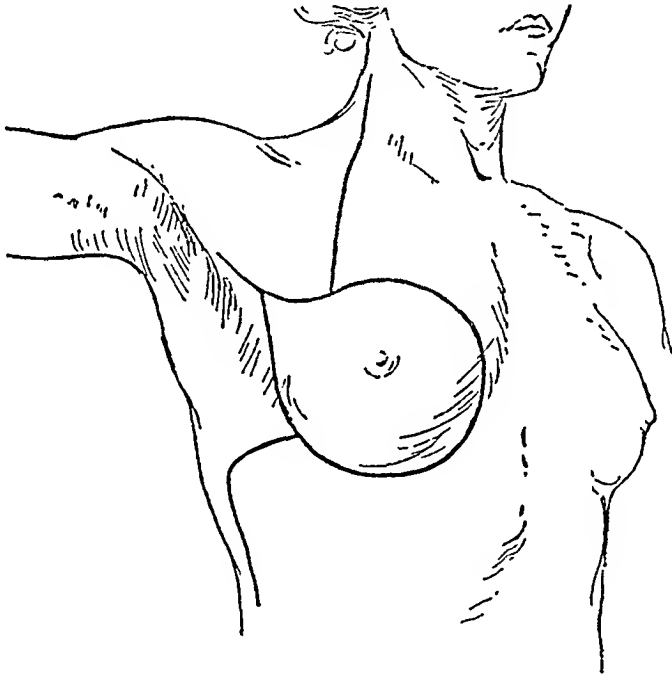


FIG. 19.—The Warren incision.

removal of the tissues from the front of the thorax was the first step and later the clearing out of the axilla. Exposure of the epigastric fascia was not planned for, and the formation of plastic skin flaps was not deemed important, because reliance was placed upon skin grafting to cover in such raw areas as were not readily covered by traction on the edges of the primary wound. Fig. 19 shows the additional lines of incision suggested by Warren (*ANNALS OF SURGERY*, 1904, xl, 827). The posterior incision curving backward and downward from the middle of the primary incision outlines a flap which later is raised and turned into the wound anteriorly. This posterior incision may be extended to any degree needed to form a flap of size sufficient to meet the needs of the wound to be covered in, provided the full thickness

A, Diseases of Breast, p. 298) and the transverse incision of Stewart (Fig. 22) (*Trans. Amer. Surg. Soc.*, 1915, p. 364). It is thought that the cicatrices of wounds in the axilla by their contraction are likely to limit the movements of the arm, or by their tenderness make the wearing of clothing and the free use of the parts painful. Œdema of the limb, with less reason, has been attributed to the axillary scar also. It is true that an exposed and contracted and tender scar, especially if

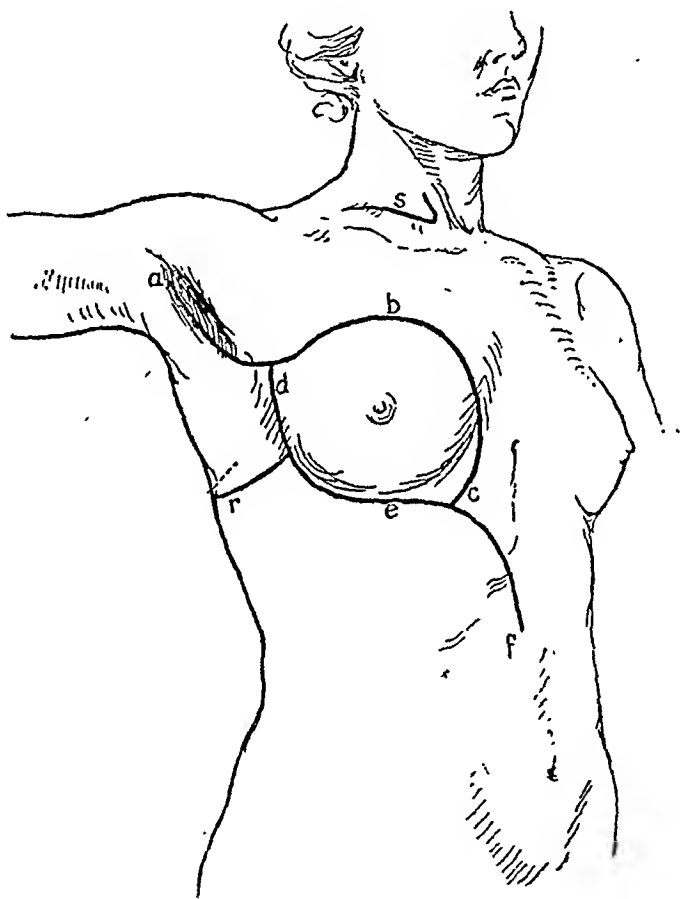


FIG. 23.—The Pilcher incision.

running along the anterior fold of the axilla or upon the front of the shoulder, deserves all that has been said against such scars, and they must be carefully avoided. To avoid them, however, it is not necessary to forego the advantages and convenience for the full exposure of the axilla and for having ready access to all its recesses which attach to a proper longitudinal incision. It is true that a para-axillary incision by reason of the relaxation of tissue produced by the extensive skin undermining, which is a part of the accepted technic, may be adequate for

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convenient and valuable incision in many cases. It has the disadvantage of leaving the scar exposed on the anterior edge of the axilla. It may be resorted to with greatest facility in patients who present in the region involved a fairly loose and distensible skin. To it will have to be added other lines of flap formation in cases involving the lower hemisphere. There is no reason why the incisions of Warren and Jackson should not be used in the same case. In actual work the surgeon finds that peculiarities of the disease as to its extent and location, of the conformation of the individual, of the qualities of her tissues make of every patient a personal problem, often requiring great

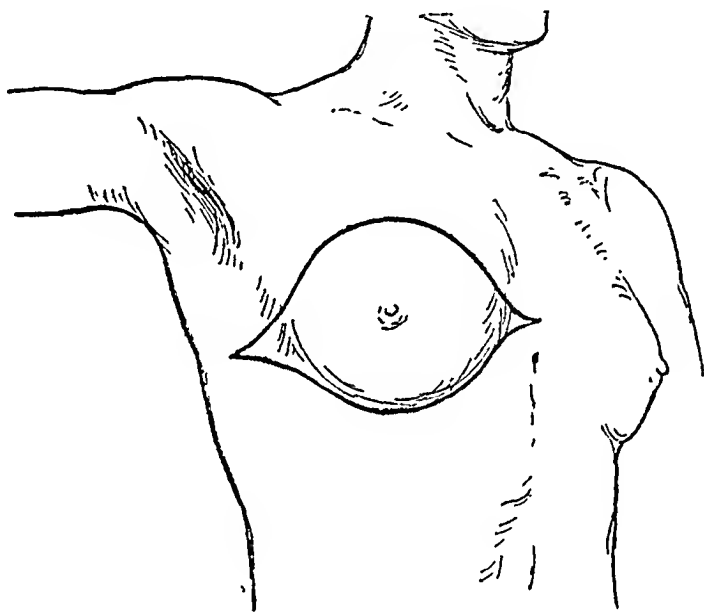


FIG. 22.—The Stewart incision.

ingenuity and skill, and full command of the resources of plastic surgery to secure for that patient the wound covering to be desired.

It is now the general practice among surgeons to complete the axillary dissection before proceeding to the removal of the tissues from the front of the thorax. By so doing the more important blood-vessels are divided at their point of origin, and the length of time during which the greater portion of the great wound is exposed uncovered is reduced to a minimum. The natural approach to the axilla is by a longitudinal prolongation outwards between the axillary folds of the incision circumscribing the breast. Various para-axillary incisions, more or less vertical to the axillary folds, have been proposed as a substitute for the more common longitudinal incision. Such is the vertical incision of Kocher and of Rodman (Fig. 21) (Pl. xliii,

thence passes outwards around the lower border of the breast which it circumscribes until it meets the primary incision at the base of the axilla. A glance at Fig. 23 will show these incisions better than the fullest description. By such an incision it is possible to satisfy thoroughly and systematically all the indications presented in dealing with breast carcinoma, save the supraclavicular exposure for which a separate incision is best as shown in the Fig. 23, S. Fig. 16 shows the extensive area of axilla, thorax wall and epigastrium uncovered which such an incision makes possible. For its closure by suture it is possible to mobilize its borders by various liberating incisions, which will be determined by the judgment and ingenuity of the surgeon in each particular case.

A comparison of the lines adopted in our own work and those suggested by Handley (Fig. 24) will show that they are practically identical in their main features.

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## RESULTS OF OPERATIONS FOR TUMORS OF BREAST

sufficient access to the axilla in many cases, but to us they have seemed imperfect and unsatisfactory substitutes and we have not employed them. We, in common, as we believe, with most surgeons, use in the axilla a line of incision somewhat undulating, with its convexity approaching the posterior axillary fold (Fig. 23). This tends to construct a more generous axillary flap that becomes of special value later to cover in the axilla without tension when the final suture is being made. It ensures the full free extension of the arm, and as the line of suture falls into the concavity of the axillary space it is out of the way of the friction and pressure of clothing when active use of the arm is resumed. We confess to a distinct preference for the wide

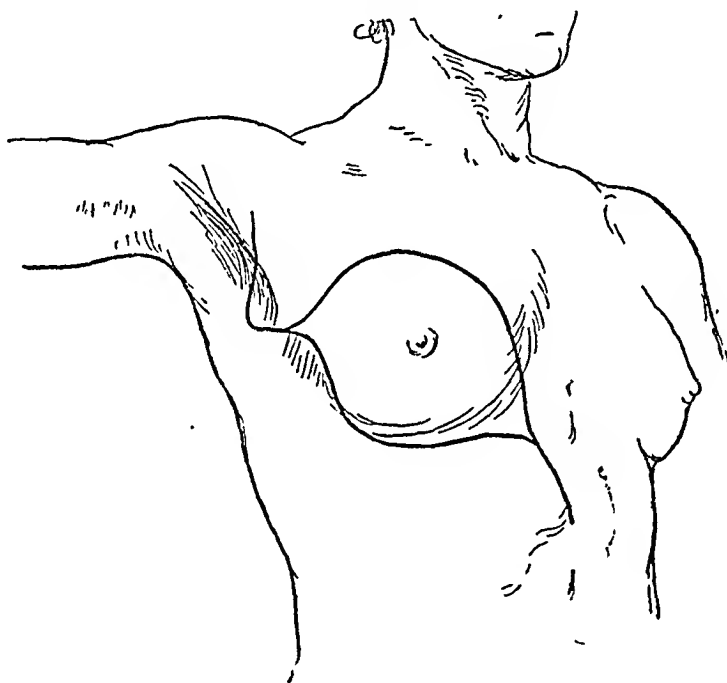


FIG. 24.—The Handley incision.

and unobstructed approach to such a region as the axilla which such an incision presents, and are persuaded that its advantages decidedly outweigh its possible disadvantages.

As this incision advances upon the front of the chest it sweeps upwards, reversing its curve; the distance above the nipple where it will be carried will depend upon the location and extent of the cancerous mass in the breast, observing the precautions and limitations which have been discussed in Section A. The inner end of the incision follows the margin of the breast on the sternal side where it joins with a lower incision which begins in the epigastrium and extends up to the inner margin of the breast, where it meets the upper incision, and

The position is not unlike that taken by the man who feels called upon to intervene in a family quarrel; and fortunate indeed the interventionist, upon whom both sides do not finally fall, to his eternal damnation!

Is there any wrong which needs righting? I feel that there is, because for many years now I have watched young men go out from the medical schools with ideals which are certainly broader because of the improvements in the laboratory courses now in force in our medical schools. They go into our hospitals, and the next time I see them their ideals have been changed to the more narrow ideals of pure practice. The laboratory means little to them, the laboratory training in the art of acquiring knowledge has vanished, the use of books as tools seems to have been forgotten. If it be not a fact that something is wrong why does the committee of this academy find it needful to issue such an appeal as the one which we have all so recently received?

Now part of the trouble, which our committee thinks must exist, and I am sure exists, may be the fault of ourselves. We have allowed the academy to become a clearing-house of experience, rather than a clearing-house of knowledge. In part it may be due to that defect of human nature which compels men to follow a leader. If this is the case, I would fill these meetings by making the leaders of surgery promise to attend; the rest would then come. I know it does not seem to sound quite right, but my meaning may be clear to you if I say that if I wanted to catch fleas I would first catch a dog.

The chief trouble, I believe, lies elsewhere. Somewhere between the time of leaving the medical schools and leaving the years as hospital internes, someone, something, has undermined the efforts of the teachers of the medical schools to give to the students a broader point of view. Does the fault lie with the men who teach them in the hospitals, with you practical men of surgery, or does it lie with the conditions existing in our hospitals? If it is with the conditions as they exist, who shall remedy these conditions?

I have had many young surgeons come to me for special work along certain lines. They come with two desires, to do some dissecting of the human body, to learn surgical technic by practice on the living animal. Never yet has my heart been gladdened by the sight of the would-be abdominal surgeon coming to learn the physiology of the gastro-intestinal tract. Once in a while one appears with a glimmer of the value of pathology, yet without the realization that, since pathology is only physiology gone wrong, pathology cannot be understood

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## SURGICAL EXPERIENCE AND SURGICAL KNOWLEDGE

THE ANNUAL ORATION BEFORE THE PHILADELPHIA ACADEMY OF SURGERY,  
FEBRUARY 5, 1917

BY JOSHUA EDWIN SWEET, M.D.  
OF PHILADELPHIA

ASSISTANT PROFESSOR OF SURGICAL RESEARCH IN THE UNIVERSITY OF PENNSYLVANIA

I HAVE chosen for my text the last sentence of the seventh verse of the first chapter of the book of Dionis, entitled "A Course of Chirurgical Operations, demonstrated in the Royal Gardens at Paris," by "Monsieur Dionis, chief chirurgion to the late Dauphiness and to the present Dutchess of Burgundy," translated from the Paris edition and printed in London in the year 1710:

"But it must be granted that the Chirurgion, to whose lot no more than this practical Manual and Operative Chirurgery falls, will frequently run the risque of Killing and Laming his Patients, when without the Direction of a Physician; and, even in the Presence of the Physician himself, will he not be in danger of committing Faults, if his Hand be not guided by his Head? 'Tis certain, that to walk well good eyes and agile and pliant legs are requisite, and that the one without the other is insufficient for that purpose. A blind Man, for instance, provided with good Legs, and led by a quick sighted and faithful Guide, may stumble for want of Light. So, whatever Experience a Chirurgion may have, if he have not the Knowledge which ought to direct him in his Operations, he will work in the dark; and if he be not a good Theorician, he will never prove an able Practitioner."

I have chosen this text because in conferring upon me the deeply appreciated honor of delivering this annual oration, it is to be assumed that I was supposed to have some message of interest to bring to you. If I have any such message, it is to be found in the advantageous position in which I find myself, standing midway between the theorists of the laboratory and the men of practice. This position offers me, perhaps, a slightly different point of view from that possessed by either group alone, and even makes it incumbent upon me to attempt to reconcile the opposing ideas of two, sometimes unfortunately hostile, forces.



ology has as one of its fundamental precepts, the fact that Nature will have things go her way regardless of man's wishes in the matter; yet in spite of this fundamental fact, in spite of Kelling's<sup>1</sup> demonstration of this fact sixteen years ago and Cannon's elaboration of this fact eleven years ago<sup>2</sup>—that in the presence of a normal pylorus food will not pass out of the stomach through a gastro-enterostomy opening but through the pylorus as normally (see Figs. 1, 2, and 3)—in spite of the fact that men like our own great leaders of surgery have pointed this out and with sufficient force, I cite the paper read by our own President in December, 1914<sup>3</sup>—how many simple gastro-enterostomies have been done this very day for gastric ulcer, and how many will still continue to be done for years to come, or, indeed, until our surgeons have learned to differentiate between, and rightly evaluate, experience and knowledge?

You may say that conditions are not normal in the presence of an ulcer; that a pylorospasm exists, that the operation does do good in many cases. But do you know, even, whether the operation or the real surgical rest in bed accomplished the result? Can you assure any given case that the operation will cure? Can you restore to normal unless you understand and know the normal? Are you doing 100 per cent. surgery?

Why does it take so long for knowledge to be disseminated? Why must a whole year elapse in the state of Pennsylvania before the average cancer patient sees the surgeon after he has seen the physician? Is it because the physician does not know the facts of cancer, because he has forgotten that there are other ways of acquiring knowledge beside the hopelessly narrow one of personal experience? Has he forgotten that books are tools and must be used to be kept bright? Must so many cancers of the breast be concealed from the physician until the present tendency in woman's dress fails to conceal them from the world? Will any change for the better occur until our young men can be made to see that the experience of four surgical dispensaries is of less value than the experience of one appointment, with the time that would be spent in the other three devoted to reading the wisdom of the past or to adding to the sum of knowledge by laboratory work?

Part of this difficulty is due to the methods in vogue in surgical teaching and writing. Since surgery always presents a condition in which something must be done, a surgeon must act, and he does that which seems to him best. But how often, even to his audiences of surgeons, does he say that that which he is about to do may be useless,

without knowing the basal physiology. Why is this? Has no one pointed out to them that the "when" of pathology and the "why" of physiology are of far greater importance than the "how" of anatomy? Has no one pointed out that while anatomy is the foundation stone, one who has climbed to its very top is still unable to even reach the place where the builders of to-day are working? Is it because the teaching of the writer of our text is less true to-day than it was two centuries ago, "if he be not a good theorician he will never prove an able practitioner"?

The pure theorist is not entirely free from blame. The value of pure science taught for its own sake is unquestionable, but since we are training men for medicine and surgery, the laboratory which helps in that training need not be too proud of its purity. It would seem, too, as though these exponents of pure science might more often permit us to catch a glimpse of their beloved mistresses, minus some of the veils of language and technicality. But since I am talking to you practical men, I shall refuse you the further comfort of thinking of the faults of the pure theorists. You will recall that when the mountain refused to come to that great prophet of Islam, Mohammed did swallow his pride, gird up his loins and go to the mountain.

I firmly believe that something is not right, and I further believe that this something can be expressed best by pointing out the difference between surgical experience and surgical knowledge as it is seen in a consideration of certain surgical procedures of to-day. I am aware that there is perhaps no difference between the broad definitions of experience and of knowledge, since knowledge must be defined as the sum of experience. Yet over two hundred years ago our friend Dionis perceived a difference in the common acceptance of the terms, and this difference exists to-day as then; and there certainly will be a great difference in the effect on the aspiring candidate for surgical fitness, whether you continue to emphasize the necessity of gaining surgical experience or whether you begin to point out to him by example and by precept the greater importance of gaining surgical knowledge, the sum of all human experience, which bears immediately or remotely upon the art and science of surgery.

It is so self-evident that it is banal that one must know the anatomy of a part before he can operate, but why stop there? Think for a moment of the present status of gastric surgery. The anatomists have not yet taught us the position and shape of the stomach. The Röntgenologists have taught us further that it does not make much difference where it is, so long as it is working properly. Now physi-

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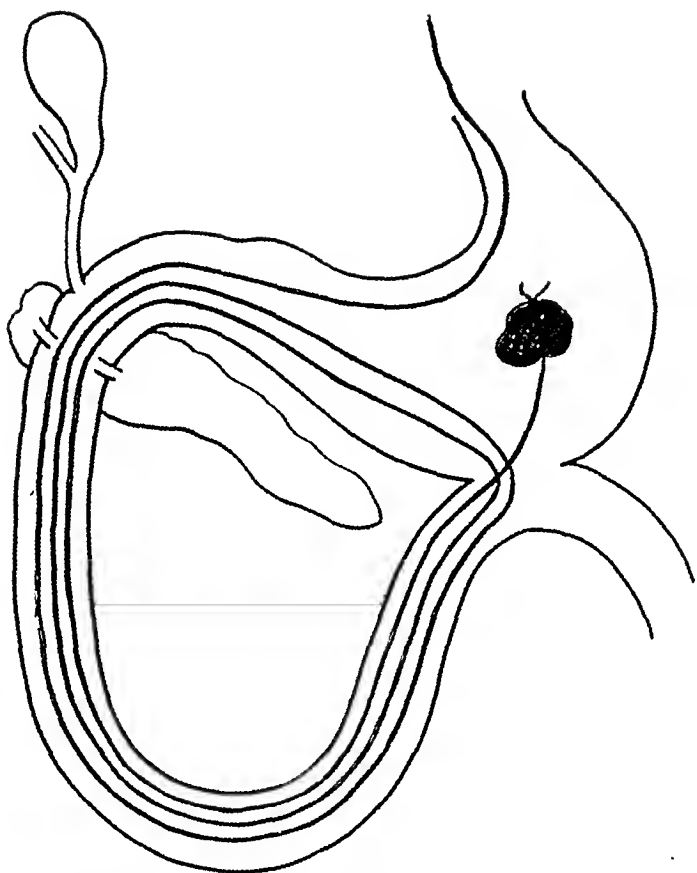


FIG. 1.—Draper's demonstration of the course followed by a bolus of food, to which a string has been attached, in an animal in which a gastro-enterostomy has previously been performed.

is certainly irrational, but he does it because we know nothing better to do? Let me quote this sentence from a recent article on the thyroid—and every man who writes thereby becomes a teacher and must remember a teacher's responsibilities: "One indisputable fact established by recent studies stands out most prominently, and it is that goitre, with the possible exception of the colloid thyroid of adolescence, is not a disease to be treated medically but is distinctly a surgical condition." So far as I can find, the only indisputable fact concerning the thyroid, aside from the fact that we do not know its function and must needs work in the dark until we do know it, is that there is a growing dissatisfaction with the results of thyroid surgery; I mean of course with the surgery of the toxic goitre. Therefore the attempts at something more than surgical intervention, the Röntgenization of the thymus for instance;<sup>4</sup> therefore we read as in Mackenzie's Bradshaw lecture<sup>6</sup>:

"Klose published in 1913 a table giving results of operations for exophthalmic goitre by various surgeons from 1896 to 1912. The percentage of cures or considerable improvement ranges from 50 to 98.7, Th. Kocher claiming 93.7 per cent. and Mayo 97.8 per cent. The percentage of deaths allowed by Th. Kocher was 1.3 and by Mayo 2.2. These figures, I have no hesitation in saying, should be received with great reservation."

"A more convincing report has recently been published by Judd and Pemberton . . . In this the 97.8 per cent. of cures or considerable improvement has fallen to 70 per cent., but even that is, I am sure, much too high if the cases operated upon are true cases of exophthalmic goitre."

It is idle to retort that Mackenzie is only a medical man. Our medical friends are as acute observers as are we. I regret to say that as a class they are better trained in the art of acquiring knowledge; and they doubtless see more of the unsatisfactory results of thyroid surgery than does the surgeon, because the patients, having tried surgery and found it wanting, can do naught else than seek the comfort of medicine, small comfort though it may be. Mackenzie's refusal to accept surgical statistics need give no offence to the surgeon who in the past few years has been devising schemes and systems for following up his cases, since every such invention but proves anew either that he has just awakened to the necessity for finding out what he has been accomplishing, or at least, having awakened, finds his present system inadequate. We must permit others the pleasure of criticising things which we ourselves criticise in ourselves.

## SURGICAL EXPERIENCE AND SURGICAL KNOWLEDGE

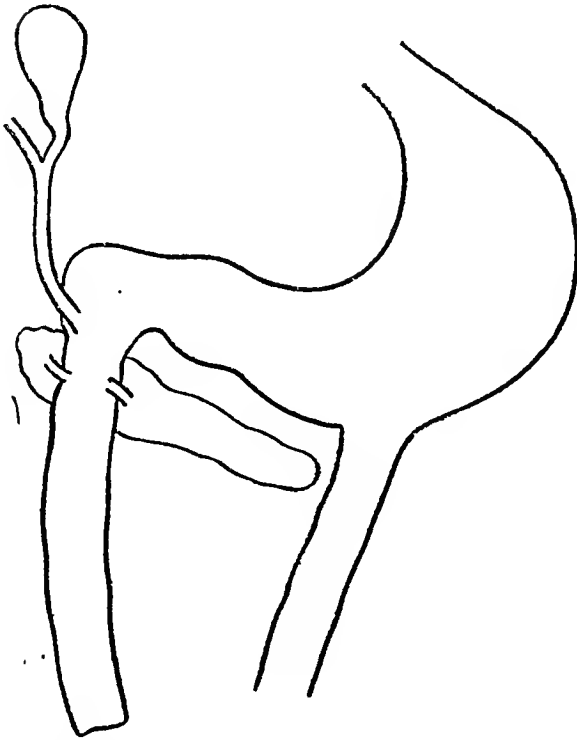


FIG. 2.—If the duodenum be cut and turned in at a point as indicated in this diagram, the lower end being anastomosed to the stomach by an end-to-side as shown, or by the ordinary lateral gastro-enterostomy, a certain number of these animals will die with all the symptoms of high intestinal obstruction.

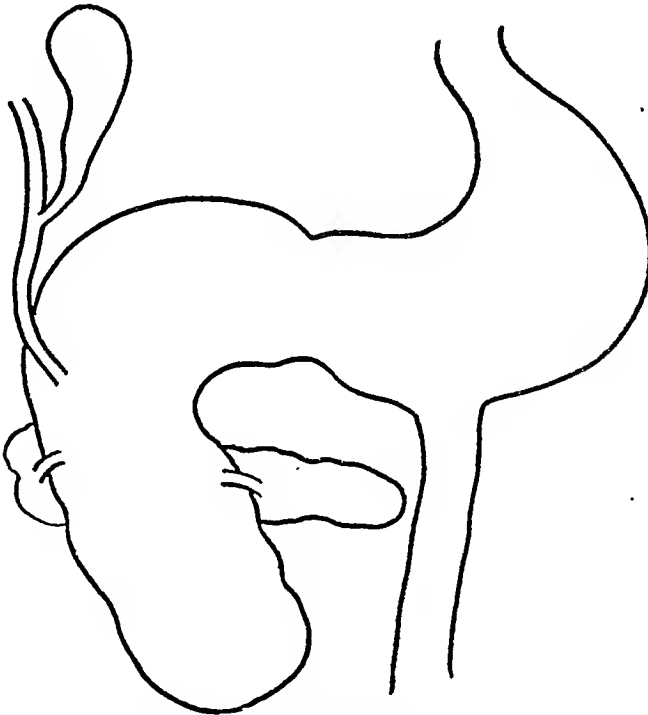


FIG. 3.—Some animals operated as in Fig. 2 will live, showing at autopsy an enormous dilatation of the blind end of the duodenum or else less dilatation but extreme hypertrophy of the muscularis of the duodenum. Therefore, while food has passed through the gastro-enterostomy opening as shown by the animal's living in good health, the autopsy nevertheless reveals that nature has been insisting upon having things go her way.



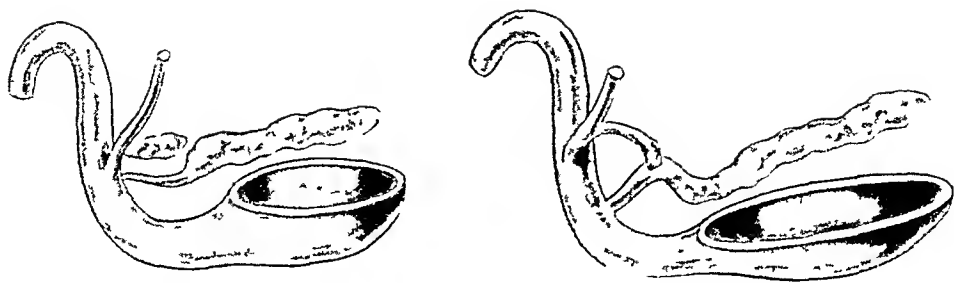


FIG. 4.—From Hamburger<sup>7</sup>—shows the manner in which the two portions of the pancreas, derived from separate anlagen, eventually fuse.

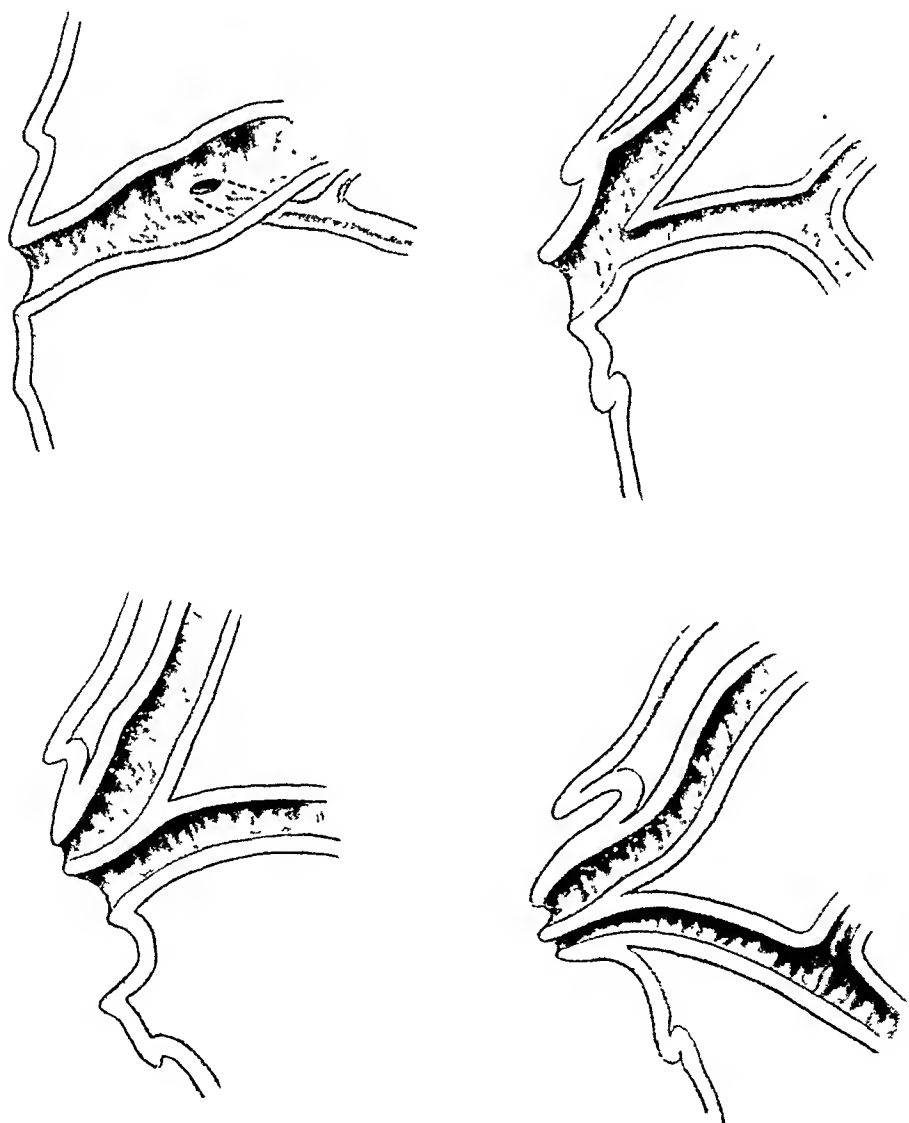


FIG. 6 —From Letulle et Nattan-Larrier<sup>9</sup>—the various types of the opening of the common and pancreatic ducts into the intestine.



development of the pancreas. The surgeon who studies this picture with a thought to the vagaries of embryologic development should not be surprised to find irregularities in the pancreatic ducts. The results of Opie, Fig. 5, published in 1903,<sup>8</sup> are not surprising, nor need Fig. 6<sup>9</sup> surprise the surgeon. Yet in the ten out of one hundred cases of Opie, where the duct of Santorini drains the greater part of the pancreas, and in Fig. 6 in certain types of papillæ, there can be no doubt that neither cholecystostomy nor cystenterostomy would help. In view of these considerations alone, the drainage of the ducts could not give 100 per cent. surgery. Moynihan, in vol. iii, Keen's Surgery, reproduces Fig. 6, but fails to apply the lesson it carries to the question of treatment. Even granting that ascending infections are mucosal infections, which in any case of ascending infection they are most likely not, we might assume that chronic pancreatitis could not occur in these cases where the ducts of the pancreas enter separately from the bile-ducts, but this would need to be mere assumption.

You may say that it is easy to reason *post hoc propter hoc*, that hindsight is notoriously clearer than foresight; that since two of our own Fellows have so clearly demonstrated the true nature of chronic pancreatitis as have Deaver and Pfeiffer,<sup>10</sup> it is a simple matter to look backward and criticise. But the point I wish to make is that Opie's work was published in 1903, that the pictures I have shown you of the peculiarities of the openings of the ducts are from a paper of 1899, and that the peculiarities of the development of the organ, to which I drew your attention, are from a paper published in 1892. I would emphasize here what is a well-known fact to those who know books, that a text-book in any growing subject is behind the times before it leaves the printer's hands, that the surgeon must keep in touch with the original sources, and that not only in the journals devoted to surgery.

Certainly this takes time, certainly it takes effort, certainly it is something each must do for himself. You cannot hire someone to think for you any more than you can hire someone to perform many other of your personal physiologic functions. He who embarks on the surgical cruise ships for no joy-ride. If we wish to raise the standard of surgery, if we would weed out undesirables, let us get this idea clear before the minds of the aspirants to surgical success, that the real surgeon must know as much as any man in any branch of medicine and then some, this "then some" being the whole field of surgical technic.

There is no doubt that the living pathology can teach some things

No student of the thyroid can ignore the opinion of the internist. Whenever there are two radically opposed points of view between surgeon and internist, it means at the very least that surgery is not convincing—it is not 100 per cent. surgery. Nor can the argument hold that if these views are presented, some patients will be held until too late by the general practitioner. If the seeking for patients conflicts with the seeking for truth, we must do without the patients. We have long since emancipated surgery from the bondage of working under a physician as they worked in the days of the writer of our text. Surgery is no more the carpentry of medicine. But the habit of gently sneering at our medical colleagues, while known to be but a mild form

## Opie's Statistics.

100 subjects examined.

10 cases, no anastomosis of the two duct systems.

4 additional cases, the two systems united only by a minute branch.

11 cases, the duct of Santorini equal in size to, or larger than the duct of Wirsung.

FIG. 5.

of mental exercise to the big minds of the leaders of surgery, is too often taken seriously by the student, to his own detriment.

The surgery of the pancreas offers several splendid examples of what I would impress upon your minds. In one of our most recent text-books, Moynihan writes,<sup>6</sup> in relation to the treatment of chronic pancreatitis, "The majority of surgeons follow Robson in preferring cholecystostomy, or if permanent drainage is required, cystenterostomy, if the gall-bladder is sufficiently healthy." Now such a procedure must be based upon the assumption that the infection is duct-borne, otherwise mere drainage of the duct could serve no end. It also must assume that, granting the assertion that it is duct-borne, the ducts of the pancreas could be drained through the gall-bladder. Let us look into the matter. Fig. 4 is only twenty-five years old.<sup>7</sup> It shows the

the gland itself, where the trouble lies. Here more surely than Dionis ever dreamed, will the surgeon "not be in danger of committing faults if his hand be not guided by his head?"

The operating room cannot teach these facts of physiological chemistry; therefore as much as we may hate to do it we must go to the physiological chemist, begging him on bended knee to converse in words of one syllable.

Let us not forget that the greatest lesson which surgery will read out of the Great War promises to be the Dakin-Carrel treatment of infected wounds. Let us consider how this has come about. Certainly not out of the depths of the surgical experience of an experimental surgeon. It has come because Carrel possesses the genius of appropriating knowledge to the needs and purposes of surgery; and therefore he made use of the knowledge of the pure chemist Dakin. Not only that the ends of justice and fairness may be met, but that all may realize the importance of applying all knowledge to surgery, let us always think of and speak of the Dakin-Carrel treatment of infected wounds rather than the Carrel treatment. No better example of what I am trying to emphasize could be found.

Now let no one go from here thinking that I have minimized the importance of surgical experience or of surgical judgment, which can only come from a proper combination of common sense, experience and knowledge. Neither the writer of the text, nor I, nor any one in the two hundred years between us would divorce experience from knowledge. The point we would make is that the one without the other is just one-half a whole, and "if he be not a good theorician he will never prove an able practitioner."

You may tell me that the trouble lies with hospital conditions; that there is so much routine to be done that the spirit needed to encourage the search for knowledge is crushed, and all the young surgeon can hope to do is to learn what he may from experience. You may tell me that the blame for multiple hospital appointments in dispensaries and hospital services lies with the boards of managers. I will not venture into your own field, but I will point out to you that you will either change these conditions or someone will change them for you.

We hear to-day a great deal about the full-time idea in schools and hospitals. Now do not be misled that this idea is being discussed because it has been started at the Johns Hopkins and at St. Louis and is being started in Chicago; nor is it being discussed because the Rockefeller Foundation is behind it. It is being discussed because of

that the dead pathology cannot teach, that it can teach many things better. There is no doubt that human vivisection—I use the term before a body of surgeons and do not care if over-zealous ladies wish to misinterpret it—is superior to animal experimentation, wherever it can be utilized; but living pathology does not supersede the basic pathology of the microscope. It cannot stand alone, nor is it intended by its most able exponent that it should stand alone.

The operating room teaches physiology, but not the whole subject. For instance, there can be no doubt that the whole picture of acute pancreatitis can only be explained by the activation of the proteolytic fermentogen of the pancreas, not in the intestine where the enterokinase normally activates trypsinogen into trypsin, but abnormally, in the gland itself or in the peritoneal cavity. This activation is brought about by the action of some unknown substance set free from the tissues under the conditions of autolysis. Therefore any process, infectious—though not all infections—embolic, mechanical, which can injure cells and permit autolysis may start the process of activation, and once started it is probable that the products of tryptic digestion themselves can in turn activate the fermentogen.<sup>11</sup> This fact is based on the evidence of painstaking researches, finished and published long before Körte wrote<sup>12</sup> in regard to acute pancreatitis:

“So now the majority of surgeons recommend the exposure of the inflamed pancreas; while some are satisfied with draining the surface of the pancreas by gauze and tube, others advise to go on into the diseased organ. As I have explained above, I join the latter and believe that by this means one lessens the inflammation and prevents more extensive necrosis.”

Yet Körte grants but five lines to a discussion of all the work on pancreas poisoning, the understanding of which clears up so many of the problems of the surgery of acute pancreatitis. We know why injuries of the organ during digestion are more serious than at other times, there is more zymogen present to be activated. There is no need for an elaborate classification of acute pancreatitis, since the various classes into which the disease has been divided are but degrees of the same process. The problem of the time of operation becomes clear. It is a progressive process, progressing under its own power, progressing more and more rapidly as it gains headway, therefore the sooner we operate the better. The question of drainage ceases to be a question; a means of escape for the infection, which may be present or so soon will appear from the neighboring intestines, and for this activated pancreatic secretion must be provided and must extend into

every hospital which has an interne, whether you will teach or not, to keep up the standards of the schools. You are the teachers of surgery!

I lay no claim to originality in this idea I have endeavored to present to you. I chose my text indeed from the writings of a surgeon of the long dead past. This is not the first time that this thought has been presented in this same place on this same occasion. What but this same idea prompted Ross to write in the annual oration of 1913: <sup>13</sup>

"Experience must set its seal deeply upon him who aspires to the heights of the surgical art. Each case must carry its lesson, however slight. The work and experience of others should be weighed in the balance.

"And granted that the surgeon has those qualifications which are so necessary to him, what is it that will enable him to further advance the science and art of surgery?

"Primarily it is the ability to profit by the experience of others, and the constant endeavor to add something new, seem it ever so trifling, to the fund of acquired knowledge."

And again, "And so the true surgeon cannot be too narrow a specialist. Specialism in modern surgery is necessary, but even more necessary is the well-grounded, thorough man who combines with his highly specialized vision openness to facts that lie beyond his immediate horizon, and an ability to interpret them."

Going back but two years more, we find the same thought underlying the annual oration of 1911, and summed up by Ashhurst in the last paragraph: <sup>14</sup>

"To know the wisdom and accomplishments of the past, and from them to gain a clearer vision of the needs and the possibilities of the future; to record and to study the experiences of the present, and compare them with the learning of others; to recognize the shortcomings and the disadvantages of current methods and theories, and to search for better; to let neither feeble health nor prosperity, neither the indolence of youth nor the procrastination of advancing years divert them from the path of learning and of progress; to prove all things and hold fast to that which is good: this is the patience of the saints, this is the patience of surgery."

I have ventured to presume upon this same topic to-night, because if I had any criticism of these two presentations from which I quote, it would be that they were too masterly, too scholarly, and slid softly and gently over our heads. Most of us are so constituted that the stars of heaven are not seen so clearly as are those stars perceived after

dissatisfaction with existing conditions, and unless these existing conditions are changed it will come here. This dissatisfaction is with the men who hold hospital appointments and give to the hospital nothing more than the gleanings of their own experience. The dissatisfaction is with the men who hold so many hospital appointments that they have not the time to give more than gleanings, even though they are capable of better things; with the men who, having ideas, have only time to pass them on to their assistants, who pass them on to the internes, who pass them on to the head nurses, who pass them on to the probationers, who pass them on to the orderlies, who pass them on to the bed-pan; dissatisfaction with the men who use the hospitals for gaining experience and never hand back to the hospital a quid pro quo in the form of crystallized experience or knowledge.

You give your time to the ward patients, you keep your appointments promptly, the wards are getting as good treatment as other hospitals, your mortality is as low, your operating staff is well trained? I should hope so—but is this enough? If you drop out to-morrow, will your hospital be any the better for your having worked there? Will the thousands who are to come be treated better because you treated the tens who were there?

These are the questions in men's minds which are leading to the discussion of the full-time idea. I do not know personally if it be the ideal; I do not know, if it were ideal in one place that it would necessarily be generally applicable. We are the servants of convention and custom in surgery as in life—even a musical comedy would fall flat among the naked natives of Africa. But I do know that something will be done to force from surgeons, in return for surgical experience, a commensurate quota of surgical knowledge.

If you do not believe that I am right, look around the country to-day, and I think you will find, without exception, that the men who are advancing the art and science of surgery are one-hospital men, that the hospitals whose names are associated with surgical progress are essentially one-man hospitals.

I do not represent any pessimism in regard to Philadelphia surgery. No city in the country, from the placid eastern coast over the western prairies to the Golden Gate, boasts as many great surgeons to the square inch as does Philadelphia. We would make it a post-graduate centre. Then remember that post-graduate centres are the outgrowth of undergraduate centres, that they do not spring full-panoplied from the head of an oil well. The undergraduate school of surgery only begins with the diploma and it is up to you who teach in

# THE RESULTS OF THE TREATMENT OF LYMPHOSARCOMA BY MEANS OF X-RAYS AND OTHER METHODS

BY ARTHUR FENWICK HOLDING, M.D.

OF NEW YORK CITY

DURING the past four years it has been our privilege at the Memorial Hospital, New York City, to observe the therapeutic results obtained in over 700 cases of inoperable carcinomas, sarcomas and allied conditions treated by means of X-rays, radium, toxins, vaccines, etc. In a publication<sup>1</sup> based upon the critical analysis of 258 of these cases, in which the diagnosis was verified by microscopical examination, treated by the X-rays, it was shown that:

(1) Primary improvement was common in inoperable carcinomata of the skin, breast, testes, lymphosarcomata, leukæmias and pseudo-leukæmias.

(2) Most of these cases eventually relapse and die of the disease.

(3) The patient's lives were prolonged and made more comfortable.

(4) Pending the discovery of the real cure for cancer, radioactive methods give results in certain classes of cases which no other methods have ever attained or surpassed.

(5) In some instances these ameliorations were very striking and deserve particular attention in the hope that eventually we may discover means of making these ameliorations more lasting and even permanent.

This series of thirty-five cases of lymphosarcoma offers an unusual opportunity for comparing the results of different methods of treatment in this disease, and it is for this reason especially that the present report is prepared. The series includes several anatomical types, as lymphocytomas, large round reticulum cell sarcomas, tumors approaching atypical Hodgkin's disease in histology, and lesions approximating the chronic granulomas. It does not include any of the embryonal epithelial tumors (endotheliomata nor infectious granulomata) which frequently resemble lymphosarcoma so closely that they are diagnosed as such.

The writer is aware that there are many variations in the anatomical structure, locations of the lesions, and natural history of these and various types of tumors, which have an influence on their treatment. This subject will be covered in a later communication. Here I will

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<sup>1</sup> Soon to appear in the American Journal of Medical Sciences.

a blow on the head with an ax. My hope is that I may have brought close home to you, who are the teachers of surgery, though you may not have the title of professor, the truth of our text—"Whatever experience a surgeon may have, if he have not the knowledge which ought to direct him in his operations, he will work in the dark; and if he be not a good theorician he will never prove an able practitioner."

Coleridge says, "To most men experience is like the stern lights of a ship, which illumine only the track it has passed." Are you leaning over the stern rail, watching the turmoil of the waters raised by the propeller, not knowing whether the propeller is turning forward or backward? Get up on the bridge, steer by the stern lights of the ships that have gone before. From the bridge you can look back over your own track, seeing it perhaps the clearer if not too near. From the bridge alone can you see these stern lights of other ships. Only there can you follow the charted paths; only there can you keep your ship in line of battle.

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worse; other agents were then added to the treatment; in five of these cases the other agents resorted to were radio-active methods, and the patients made rapid improvements as soon as this change was made; one of these patients became symptom-free. The other four toxin cases which were not put on radio-active treatment did not improve. One case was treated by mixed toxin alone; he was unimproved and is now dead. Fourteen cases were treated with mixed toxin in conjunction with other methods; six were improved; six were unimproved; two disappeared from observation. Five cases were treated with Röntgen rays alone; of these, one has been symptomatically well for three years; in two the masses disappeared but later presented in other parts of the body, and both patients are now dead; the other two cases were unimproved. Twenty-three cases in all were treated with massive doses of Röntgen rays, of these fifteen were improved.

Two cases were treated with radium alone; one has been symptom-free for one year; the other was improved for a time but is now dead. Seven cases were treated with radium in conjunction with other methods; one has been symptom-free for one year; six were improved.

*Cases Symptom-Free.*—Five cases have been symptomatically well respectively 3 years, 4 years,  $3\frac{1}{2}$  years, 1, and 1 year. The first, a groin case, on exploratory operation was found to be too extensive for removal, and was treated with the Röntgen rays alone. The second was treated by surgery and mixed toxins and has been symptom-free for four years. The third, primary in the cervical glands, was treated first by operation, and followed by post-operative administration of mixed toxins. In spite of this treatment, recurrences took place. The patient was then treated with massive doses of Röntgen rays, and has been symptomatically well for  $3\frac{1}{2}$  years. The fourth was treated by radium over the tonsil and X-rays over both sides of the neck, axillæ and mediastinum. She has been symptom-free for one year. The fifth was treated by radium over the tonsil and neck and has been symptom-free for one year.

*Cases Improved.*—Thirteen cases were improved. Three were treated with Röntgen rays alone. Two were treated with Röntgen rays and radium. One was treated with radium alone; thus making a total of six cases out of thirteen improved cases due to treatment by radio-active measures alone. Three of the cases that were improved were treated at first with an autogenous tumor vaccine with improvement; they were also given Röntgen treatment. Two of the improved cases were treated with mixed toxins at first, without improvement; later they were treated with radio-active methods and improved. One of the

## RESULTS OF TREATMENT OF LYMPHOSARCOMA

merely state that the observations of ourselves and others make it logical to assume that the reason lymphosarcomas respond better to radioactive measures than any other type of sarcomas is because of the predominance of the nuclei in lymphosarcomas. It is obvious also, that the early and localized forms of this disease are the only ones that may be expected to yield favorable end results.

The accompanying table summarizes observations made in these thirty-five cases of lymphosarcoma treated by various surgical methods, including excision, radium, X-rays, mixed toxins, serums, vaccines, etc.

The ages of the patients varied from twelve to seventy years. Twenty-three cases were males and twelve were females. The duration of the disease varied from two months to seven years. In fifteen of the cases the disease first manifested itself in the tonsil; in fourteen of the cases the disease first affected the cervical glands, and in six cases other glands in the body were first affected. Cases with primary manifestations occurring in the tonsil were most malignant. Thirty of these patients are dead or dying. Five are symptomatically well. In twenty-two cases from one to five operations had been performed, and the patients presented with post-operative recurrences. In none of our cases was excision used alone. In most of our cases several methods of treatment were used as shown in the table of cases. As a rule the treatment which promised most in any individual case was first employed. If adequate improvement was not noted within a reasonable length of time the special treatment selected was superseded by some other treatment or in some instances adjuvant treatments were given in the endeavor to control the advance of the disease and in the best interests of the patients.

*Experimental Methods.*—Three cases were treated with autogenous vaccine derived from tumors excised from the patient; one case was treated with serum from a goat which had been given immunizing doses of a diphtheroid organism isolated from the patient's tumor; one case was treated with colloidal copper; two with other experimental methods, all of which yielded no conclusive therapeutic results.

*Older Methods.*—Eight cases were treated by surgical operations followed by mixed toxin treatment; of these, one has been symptom-free for four years; five are known to be dead and two disappeared from observation.<sup>2</sup>

Nine cases were given mixed toxin treatment at first and grew

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<sup>2</sup> Patients suffering from malignant tumors and "disappearing from observation" as a rule are patients that have gotten no results or bad results and have become discouraged.

Case No.	Age	Sex	Duration	Locus	Treatment			Symptoms Well	Improved	Unimproved	Present status	Remarks
					Number of operations	X-ray	Other methods					
1	40	F	7 years....	Thigh, abdomen	5	X	Autogenous vaccine from tumor	..	I	..	Dead.....	Did not improve under vaccine. Did improve under X-ray treatment.
2	24	M	3 years....	Thigh, groin..	I	..	Mixed toxins. Colloidal copper	..	..	I	Dead.	
3	26	M	5 months..	Tonsil, neck..	I	X	Mixed toxins. Autogenous tumor vaccine	..	I	..	.....	Mass in neck diminished under X-ray treatment. Did not diminish under toxins.
4	19	M	3 months...	Tonsil, nose, pharynx, neck	.....	.....	Radium.....	..	..	I	Dead.....	Radium dosage too small.
5	55	M	2 years....	Neck.....	2	..	Mixed toxins.	I	..	..	.....	Has been symptom free 3 years.
6	48	F	6 months...	Groin.....	..	X	.....	..	..	..	Dead.	
7	55	M	1 year.....	Axilla, neck, lung	I	X	Radium.....	..	..	..	Still under treatment	Grew worse under toxins; improving under radium.
8	60	F	1 year.....	Tonsil.....	..	..	Mixed toxins. Radium	..	I	..	Dead.	
9	47	M	8 months..	Axilla, neck, abdomen	..	..	Diphtheroid serum	..	..	I	Dead.	
10	37	M	6 weeks....	Nose, tonsil, neck	..	..	Mixed toxins.....	..	..	..	Dead.	
11	28	M	2 months...	Neck.....	I	..	Mixed toxins.	..	..	..	Dead	Grew worse under toxins; tumors disappeared under radium on tonsil. X-ray to neck.
12	42	M	6 months...	Tonsil, neck...	I	X	Mixed toxins, Radium	..	I	..	Dead	
13	43	M	9 months...	Spleen, neck, axillæ, groin	I	X	.....	..	I	..	Dead	

## RESULTS OF TREATMENT OF LYMPHOSARCOMA

improved cases was treated with mixed toxins alone at first without improvement; the toxins were stopped and radium treatment instituted, under which the case improved.

*Cases Unimproved.*—Of the thirty-five cases, nineteen are known to be dead; one is dying; five have disappeared from observation. Thirteen cases of the thirty-four were improved for periods varying from one month to one year. Twelve cases of the series were unimproved.

It is worthy of note that this series of cases is reported from an institution in which the toxin treatment was carried out in an efficient manner and the series includes all the cases of undisputed lymphosarcoma that were treated in that institution during a period of four years. In the light of the fact that we are able to report only one case symptom-free where mixed toxins were used (combined with surgery), I am forced to conclude that some other constitutional treatment for this class of malignant tumors is as sadly needed as it has been earnestly sought. The fact that the mixed toxins act as a constitutional agent must stand in their favor, and there seems to be some evidence of a certain influence on lymphosarcoma from the use of mixed toxin treatment as indicated by an occasional cure reported by this method.

The series of cases treated in this institution demonstrates conclusively that treatment of this group of cases by the toxins is rarely effective, whereas treatment by the X-rays and radium results in marked benefit, and even in apparent recovery, in a considerable proportion of cases. Moreover, the use of the toxins entails serious discomfort, high fever, chills, and general constitutional deterioration, whereas the X-rays and radium when properly used produce no untoward effects whatever. It is apparent, therefore, that the latter method constitutes the method of choice in all cases in which it is available, and that the toxin should be resorted to only where the X-ray and radium have proven ineffective. Other treatments also failed in the majority of cases, so that our results emphasize the well-known lethal tendency of lymphosarcoma.

Among the cases that were unimproved were most of those of youthful age in whom the disease appeared to be especially aggressive. Many patients did well or even showed definite temporary improvement until there were evidences of involvement of internal viscera, when the downward progress usually became more rapid. While the general condition of the patient usually improved with shrinkage of palpable tumors, this general improvement was not always observed. One patient died with superficial tumors almost completely absorbed.

I wish to express my appreciation of the assistance rendered by the

staff of the Memorial Hospital; without whose coöperation this work would have been impossible.

#### CONCLUSIONS

The following conclusions regarding the treatment of lymphosarcoma are warranted from the observations made in this series of cases:

1. Surgical excision is contra-indicated except in very early and strictly localized forms of the disease, and since such anatomical conditions can seldom be demonstrated to exist surgical treatment is very rarely admissible in this condition. It cannot be denied that in rare instances of what might well be called "incipient" lymphosarcoma early excision has eradicated the disease. Lymphosarcoma in an "incipient" stage, however, is so rarely encountered clinically, and even then is so rarely diagnosed before it has extended deeply, that the recognition of the condition, when it is a therapeutic possibility to cure it by excision, is a fortunate accident rather than a reasonable probability.

2. The most effective treatment for lymphosarcoma at present is by radio-active methods, rarely combined with surgery.

3. No treatment of this disease can be considered complete unless it includes treatment with radio-active methods.

## RESULTS OF TREATMENT OF LYMPHOSARCOMA

[illegible]

operative field is circumscribed by a black Japanese silk towel on which the fine threads can be easily seen. The temporary hæmostasis is secured by elastic clamps, forceps or rubber bands. The vessels are severed and the adventitia removed from the end of the vessels. The blood is washed out not only from the vessels but also from the operating field. The vessels and the surrounding parts are then covered with warm vaseline.

"The vessels to be sutured must be approximated without much tension. They are brought together by three retaining stitches, introduced at three equidistant points of their circumference. By traction on these threads, the circumference of the vessel can be transformed

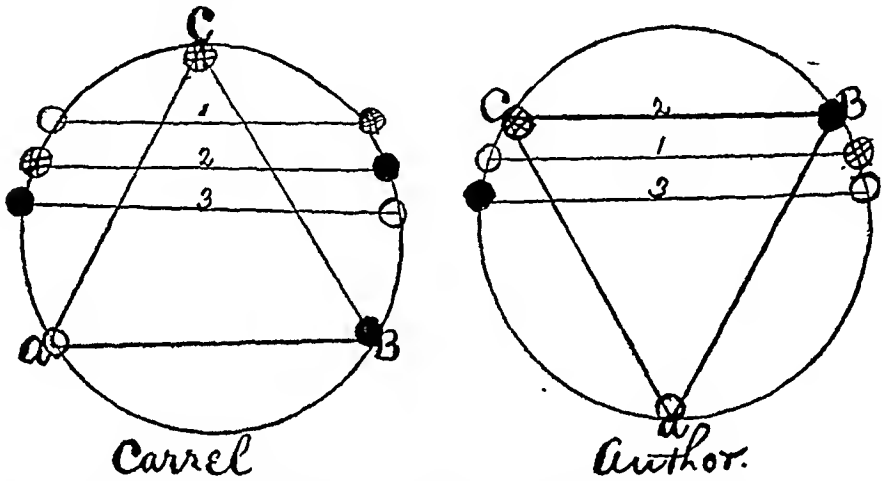


FIG. 1.—A○, first retaining and traction suture, also starting point of circular suture; B● second retaining and traction suture; C●, third retaining and traction suture. Lines 1, 2 and 3 (left figure) indicate the relative position of the corresponding sides of the triangle during the suture by Carrel's method. Lines 2, 1 and 3 (right figure) indicate the relative position of the corresponding sides of the triangle during the suture by author's modification.

into a triangle. The first retaining thread is used as a continuous suture, uniting the three sides of the triangle. During the suture great care is taken to approximate accurately the cut surfaces of section of the walls.

"In arteriovenous anastomosis the vein is generally larger than the artery. After the ends of both vessels have been approximated by the three retaining sutures with some of the stitches of the continuous suture, a relatively larger portion of the vein is taken up than of the artery, thus the caliber of the vein is progressively reduced and a good union takes place. In side-to-side anastomosis, both vessels are brought near one another, and an ellipse resected from the contiguous walls. A temporary provisional suture is introduced into the posterior margin of both vessels, but is not tied. Two retaining sutures unite either end of the openings. The ends of the retaining stitches are on the external

# A HISTOLOGICAL STUDY OF THE CIRCULAR SUTURE OF THE BLOOD-VESSELS

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THE purpose of this study is to obtain some light on the repair of sutured blood-vessels, and to determine upon a simplified technic which would render the circular suture of blood-vessels practicable in general surgery.

The first recognized successful suture of a blood-vessel was performed by Jassinowski, in 1889. He made use of interrupted sutures. Burci, in 1890, and Silberberg, in 1897, report similar results. The same year Murphy reported his method of invagination. Doerfler in 1889 first used the method now employed, the essential features of which were the use of fine round needles and fine silk, and the continuous sutures embracing all the coats of the vessel. Hirsch, Brian and Jaboulay were followed in 1900 by Payr, Bougle, Clermont, Tomaselli and Salvia. Berard and Carrel began to study end-to-end arteriovenous anastomosis in 1902. During the next years Jensen and Hoepfner and Floresco pursued the same studies. In 1905 Carrel and Guthrie had favorable results from their method of continuous sutures penetrating the media and intima. Other workers in blood-vessel suture were Ullman and von Decastello, Stich, Jeger, Borst and Enderlen, Lespinasse, Villard and Tavernier, Yamanoüchi, Horsley and Bernheim.

The results of arterial circular suture in animals by Borst and Enderlen, Yamanoüchi, Ward, Stich and Carrel by Carrel's method show 74.2 per cent. successes in a total of 148 cases. Sofotereff says that in 352 cases operated upon by the Carrel method, there were 49.8 relative percentage of successes, 15.5 per cent. by the Murphy method, and 17.6 per cent. by the Payr method of invagination with magnesium rings.

Of the methods described, Jeger considered Carrel's technic the best for the surgeon who has made a specialty of blood-vessel suture, but was inclined to believe that the Payr method, on account of its simplicity, would find a field of usefulness in war surgery.

Carrel's technic is as follows: "The round straight needles, Kirby No. 16, threaded with fine silk and sterilized in vaseline, are used. The



of the openings facilitates the use of the straight needle without inflicting injury upon the exposed intima. These temporary sutures should not be tied and are readily removed after the continuous suture has been completed. The traction is produced with the weight of the serrefines.

The histological studies of the process of healing of the circular suture of vessels have been as follows:

Carrel in 1907 reported findings after autotransplantation of jugular vein to carotid. He stated that the walls were thickened and, *vice versa*, in the transplantation of artery into vein the walls become attenuated so that it might be said that the transplant eventually shows changes in its structure in accordance with the blood-pressure to which it has been subjected. Stich, Makkas and Dowmann show the thickening of the intima and proliferation of the endothelium.

Fischer and Schmieden report histological findings in transplantation of vein to carotid removed from a dog after eighty-six days. They found a marked thickening of the media due to a hypertrophy of the muscularis and connective tissue invasion. The intima was somewhat thickened over the line of suture. They also found among the spindle-cell proliferation of the intima, some cells that resembled smooth muscle cells. They note the absence of elastic fibres in all of their specimens.

Capelle states that he found proliferation of the intima with very little changes in the media or adventitia. W. Ward found that homotransplantations, similar to heterotransplantations, eventually become absorbed. The elastic fibres, however, remain intact.

Borst and Enderlen in an autotransplantation of carotid artery after 132 days report that the elastic fibres were replaced by connective tissue. There were small areas of necrosis in the media. The sutures were surrounded by granulation tissue, containing phagocytes and giant-cells. The vasa vasorum were increased in number and somewhat thickened. The elastic fibres end at the scar and show a tendency to divide into bundles. A few very delicate newly formed elastic fibres were present in the scar itself. The muscularis showed marked atrophy.

Ribbert is quoted by Borst and Enderlen as saying that a homotransplant seems to be able for a short time at least to withstand the biological differences in body juices between the donor and host. He believes that the transplant will begin to show evidences of absorption as soon as its own tissue fluids are exhausted.

Jacobsthal claims that he saw new elastic fibres appear as early as 12 days, Borst and Enderlen, 14 days, and Faykiss in 3 weeks.

Borst and Enderlen believe that the union of the vessels evidently

surface of the vessels. The union is completed by a continuous suture. Leakage during the first minutes after the circulation is restored is controlled by gentle pressure with gauze. After two or three minutes the sponges are removed, and, if some hemorrhage persists, one or two complementary stitches are added."

I believe that it is important to avoid the use of instruments in handling the severed ends of the vessels. The adventitia is drawn over the end of the vessel with fingers well oiled with paraffin, and severed with scissors.

The third side of the triangle with Carrel's method is made accessible for suture only by twisting the vessels for a distance of 180 degrees. By introducing the first retaining stitch on the posterior side so that the triangle formed by the three retaining stitches will have its apex downward, it was found that the vessels were twisted only for an arc of a quarter of a circle or 90 degrees. The importance of this feature of the technic is particularly emphasized in an attempt to anastomose the shorter vessels, such as the renal and splenic. I find that liquid paraffin is more easily handled than vaseline, especially during cold weather.

While the eversion of the vessel ends emphasized by most of the experimenters is quite essential, this detail should not be exaggerated, particularly in the anastomosis of arteries where the histological reconstruction of the continuity of the vessel should be sought for in order to assure a perfect functional result.

The results obtained seem to prove that coaptation of the respective layers of the vessel wall can be accomplished with a simple running suture. This is illustrated in a number of the specimens which attains the object with a minimum amount of cicatrix and with an almost perfect restoration of the normal integrity of the vessels. A restoration of the intima is most essential in order to eliminate as far as possible the dangers of an occluding thrombus. It cannot be denied, however, that this can be accomplished without the practice of the mattress or double mattress suture advocated by Horsley. This is shown in the histological study of the specimens. The objection to the mattress suture on theoretical grounds would be that it has a tendency to evert the severed ends of the layers of elastic tissue and muscularis. This tendency even goes so far as to eliminate the possibility of their re-entering into the continuity of the vessel wall. I have found in side-to-side anastomosis that the use of the three-bladed clamp of Jeger very much simplifies the procedure. After the vessels have been fenestrated, the introduction of an additional temporary traction suture in the anterior margins

My specimens in which histological examinations were made include examples of end-to-end or circular sutures, side-to-side anastomosis between artery and vein, the end-to-end arteriovenous anastomosis and the transplantation of segments of vessels:

*Experiment No. 40.*—Fig. 2. Drawing. Low power. End-to-end suture of carotid. Dog No. 27. Surg. Path. No. 3729. Operation, November 13, 1915. Specimen removed November 22, 1915. Sutured ends separated by  $\frac{1}{2}$  mm. of connective tissue on one side; on the other side by 2 mm. This connective tissue at some points is dense; at other points it is loosely constructed. The intima regenerates everywhere. At one point one of the sutures lies within the vessel lumen, and is completely covered by connective tissue, with an endothelial surface. Where there was wide separation of the vessel ends, there is a considerable mass of relatively loose connective tissue on the surface which is covered with intima. In the depths the repaired vessel wall is dense and suggests osteoid structures. In the depths of the suture line at another point, very definite osteoid structure exists. There is a distinct dilatation of the lumen present at the site of the suture line.

Fig. 3. Drawing. End-to-end suture of carotid. Dog No. 27. Surg. Path. No. 3729. Operation November 13, 1915. Specimen removed November 22, 1915. Sutured ends separated by  $\frac{1}{2}$  mm. of connective tissue on one side; on the other side by 2 mm. This connective tissue at some points is dense; at other points it is loosely constructed. The intima regenerates everywhere. At one point, one of the sutures lies within the vessel lumen, and is completely covered by connective tissue, with an endothelial surface. Where there was wide separation of the vessel ends, there is a considerable mass of relatively loose connective tissue on the surface which is covered with intima. In the depths, the repaired vessel wall is dense and suggests osteoid structures. In the depth of the suture line at another point, very definite osteoid structure exists. There is a distinct dilatation of the lumen present at the site of the suture line.

*Experiment No. 47.*—Fig. 4. Drawing. End-to-end suture of carotids. Dog No. 108. Surg. Path. No. 3846. Operation January 20, 1916. Specimen removed February 9, 1916. Cicatricial tissue firmly unites one vessel end to that of the other. One extremity is slightly everted and the other is implanted upon it. The recess is so obliterated by connective tissue that the intimal lining is completely regenerated. The suture line is hardly discernible on account of the merging of the cicatrix with the sutured ends. Smooth muscle cells as demonstrated in a Van Gieson stain infiltrate the cicatrix.

*Experiment No. 1.*—Surg. Path. No. 2053. End-to-end suture of carotids. Dog. No. 313. Operation April 30. Specimen removed May 27. Strong dense cicatrix joins both ends. The lining membrane completely regenerated. Some bulging of vessel wall at site of cicatrix.

*Experiment No. 43.*—End-to-end anastomosis of carotids. Eleven days. Dog No. 56. Surg. Path. No. 3765. Operation December 9, 1915. Specimen removed December 20, 1915. Vessel wall on one side shows the ends are in perfect alignment. There is a minimum amount of scar tissue forming the suture line. On the other wall there is an eversion. The recess is filled in with fibrin and leucocytes. Cicatricial tissue firmly unites end of vessel wall to end of vessel wall.

## CIRCULAR SUTURE OF BLOOD-VESSELS

takes place by scar tissue. Minute small areas of necrosis have been observed in the media. Archibald Smith has also reported such a finding. "There is some danger of aneurismal formation following the cutting out of the silk sutures when drawn too tightly or when introduced under too great tension. The triangular-shaped groove formed by the eversion of the two vessel ends becomes covered with endothelium. The endothelium showed proliferation of a spindle-cell variety and can be observed within twenty-four hours. The sutures were surrounded by polymorphonuclear leucocytes and buried in the new tissue formation. Elastic fibres and muscle fibres disappear in the everted portion of the vessels while the elastic fibre of the media near the scar undergoes degeneration. A few delicate elastic fibres make their appearance later in the scar itself. We cannot therefore say that all the elements of the vessel wall are absolutely restored, but that scar tissue enters into the process of healing."

According to Aschoff, the vascular wounds are closed immediately by fibrin and platelets. "The degree of thrombosis depends upon the amount of traumatism inflicted, secondly upon the nature of the wall of the vessel (arteriosclerosis), and thirdly, the state of the circulation. The process is followed by a cellular proliferation which infiltrates and covers the thrombus. This is followed by invasion of the adventitia and media. The media is the seat of marked connective tissue and very slight muscle cell proliferation. New elastic fibres permeate the scar, especially the outer layers. An absolute restoration of the elastic and muscular tissue of the vessels seems improbable."

According to Yamanoüchi, union takes place by the formation of scar tissue with a partial preservation of the muscle cells, the elastic fibres being somewhat increased in number. He found that homotransplantations of vessels were followed by gradual degeneration and destruction of the transplant which is eventually replaced by connective tissue. The findings in No. 3529 and No. 2753 agree with those of this author.

Borst and Enderlen claim that the muscularis disappears almost entirely from the vicinity of the suture line.

The specimens No. 3846 and No. 3258 in this series show the muscularis well preserved and extending into the line of suture.

The presence of valves in a vein transplant does not necessarily favor coagulation or thrombus formation, as is demonstrated in several of these specimens (see Fig. 10, No. 2477).

The consensus of opinion is that the restoration of the intima is brought about by proliferation of the endothelium.

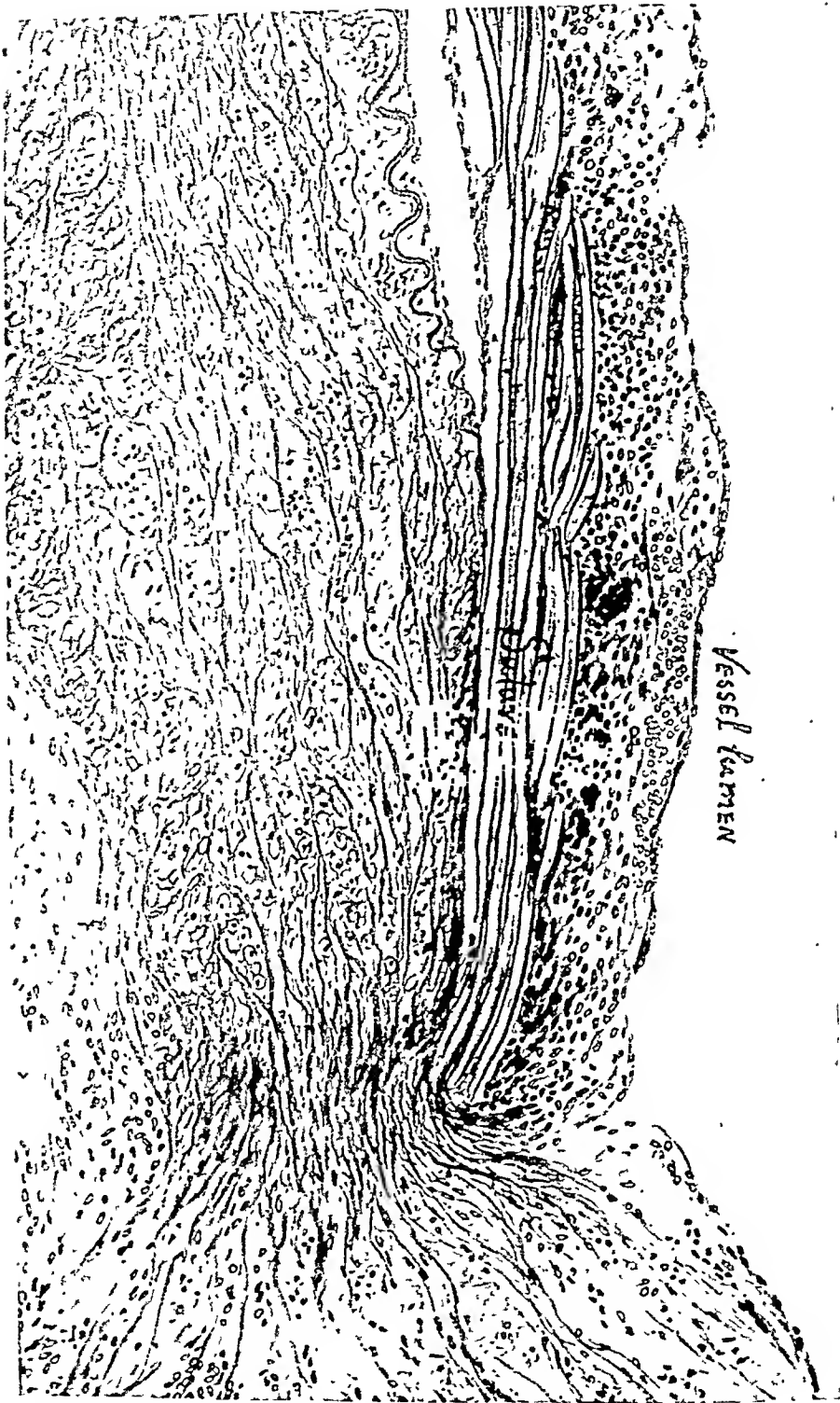


FIG. 3.—Drawing. End-to-end suture of carotid. Dog No. 27. Surg. Path. No. 3729. Operation November 13, 1915. Specimen removed November 22, 1915. Sutured ends separated by  $\frac{1}{2}$  mm. of connective tissue on one side; on the other side by 2 mm. This connective tissue at some points is dense; at other points it is loosely constructed. The intima regenerates everywhere. At one point, one of the sutures lies within the vessel lumen, and is completely covered by connective tissue, with an endothelial surface. Where there was wide separation of the vessel ends, there is a considerable mass of relatively loose connective tissue on the surface which is covered with intima. In the depths the repaired vessel wall is dense and suggests osteoid structures. In the depths of the suture line at another point, very definite osteoid structure exists. There is a distinct dilatation of the lumen present at the site of the suture line.

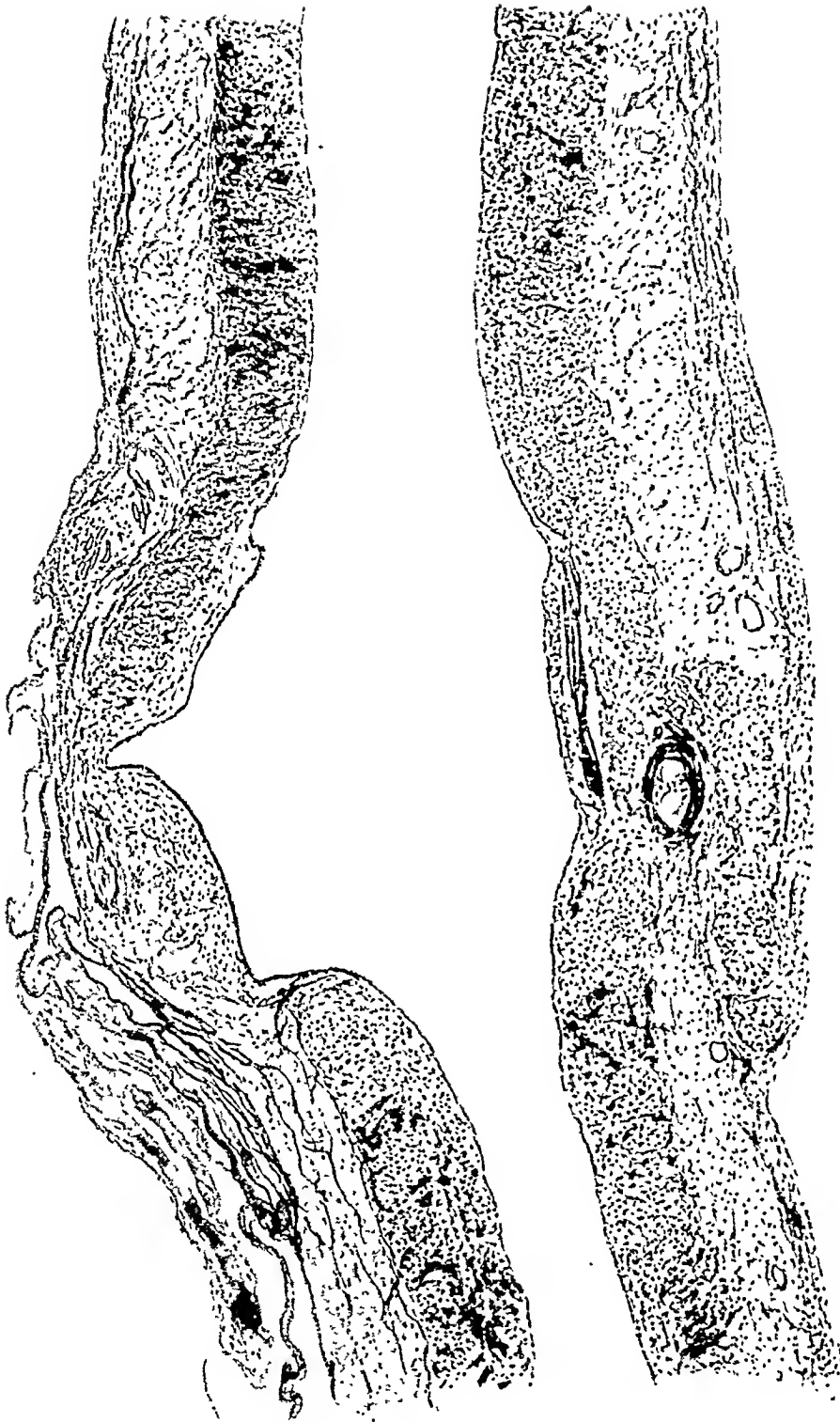


FIG. 2.—Drawing. Low power. End-to-end suture of carotid. Dog No. 27. Surg. Path. No. 3729. Operation, November 13, 1915. Specimen removed November 22, 1915. Sutured ends separated by  $\frac{1}{2}$  mm. of connective tissue on one side; on the other side by 2 mm. This connective tissue at some points is dense; at other points it is loosely constructed. The intima regenerates everywhere. At one point, one of the sutures lies within the vessel lumen, and is completely covered by connective tissue, with an endothelial surface. Where there was wide separation of the vessel ends, there is a considerable mass of relatively loose connective tissue on the surface which is covered with intima. In the depths the repaired vessel wall is dense and suggests osteoid structures. In the depths of the suture line at another point, very definite osteoid structure exists. There is a distinct dilatation of the lumen present at the site of the suture line.

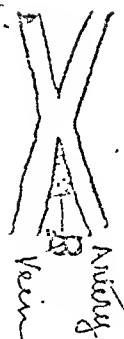


FIG. 6.—Photomicrograph. Side-to-side anastomosis between external jugular and carotid. Dog No. 386. Surg. Path. No. 3861. Operation June 18, 1915. Specimen removed February 28, 1916. Intimal surface joins intimal surface through the opening. Cicatricial tissue joins adventitia to adventitia adjacent to the opening. Sutures are well buried in the media and adventitia.

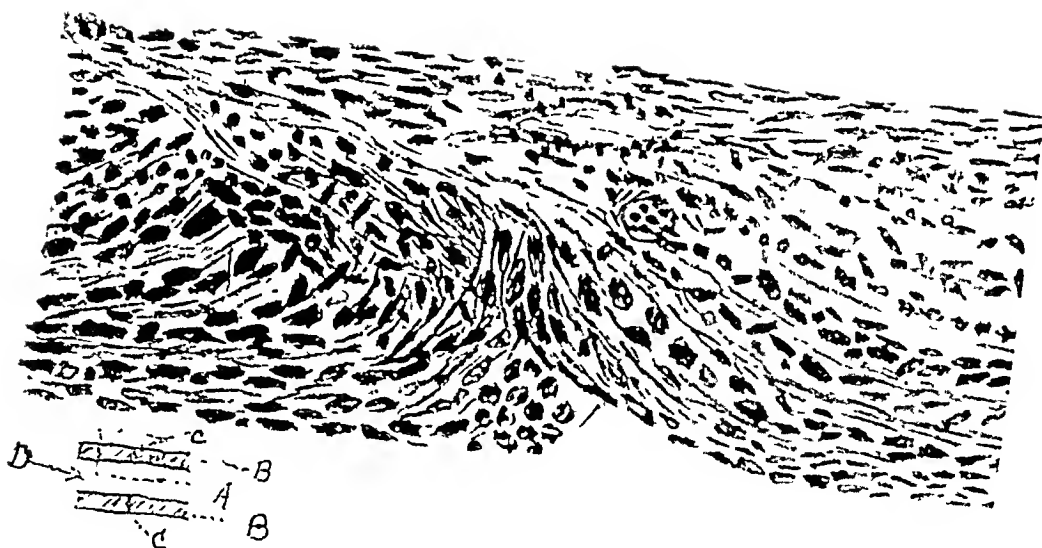


FIG. 4.—Drawing. End-to-end suture of carotids. Dog No. 108. Surg. Path. No. 3846. Operation January 20, 1916. Specimen removed February 9, 1916. Cicatricial tissue firmly unites one vessel end to that of the other. One extremity is slightly everted and the other is implanted upon it. The recess is so obliterated by connective tissue that the intimal lining is completely regenerated. The suture line is hardly discernible on account of the merging of the cicatrix with the sutured ends. Smooth muscle cells as demonstrated in a Van Gieson stain infiltrate the cicatrix.

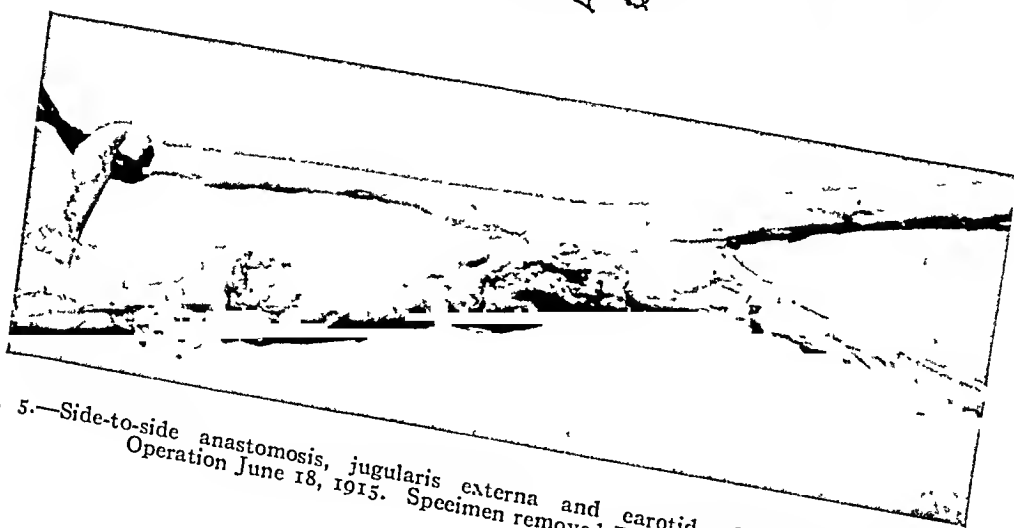
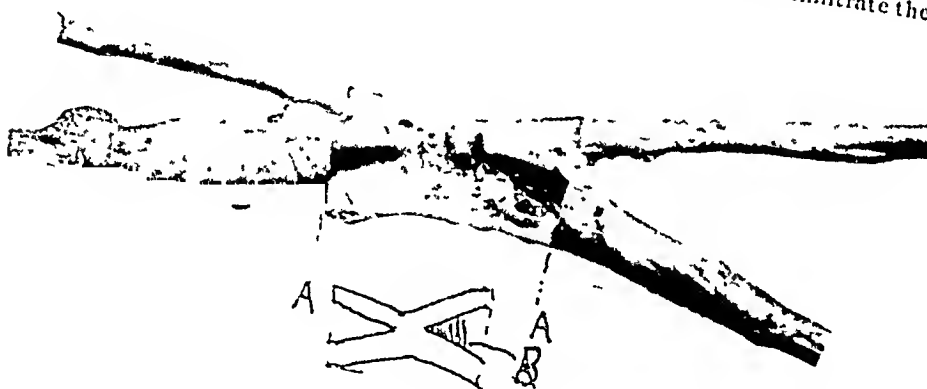


FIG. 5.—Side-to-side anastomosis, jugularis externa and carotid. Surg. Path. No. 3861. Operation June 18, 1915. Specimen removed February 28, 1916.





*Wall lumens*

FIG 8—Photomicrograph, mag 300. Autotransplantation of femoral vein to carotid. Eight days. Dog No 268. Surg Path No 2382. Space between artery wall and transplant is exceedingly small and made up of proliferating connective tissue. Surface of the transplant is undergoing some form of degeneration. Immediately beneath the wall of the transplant, active proliferation of connective tissue is seen. A suture in the intima is covered by fibrin and reparative connective tissue cells. Elastic fibres in the transplant are separated into smaller bundles. The wall of the transplant is apparently undergoing degeneration.

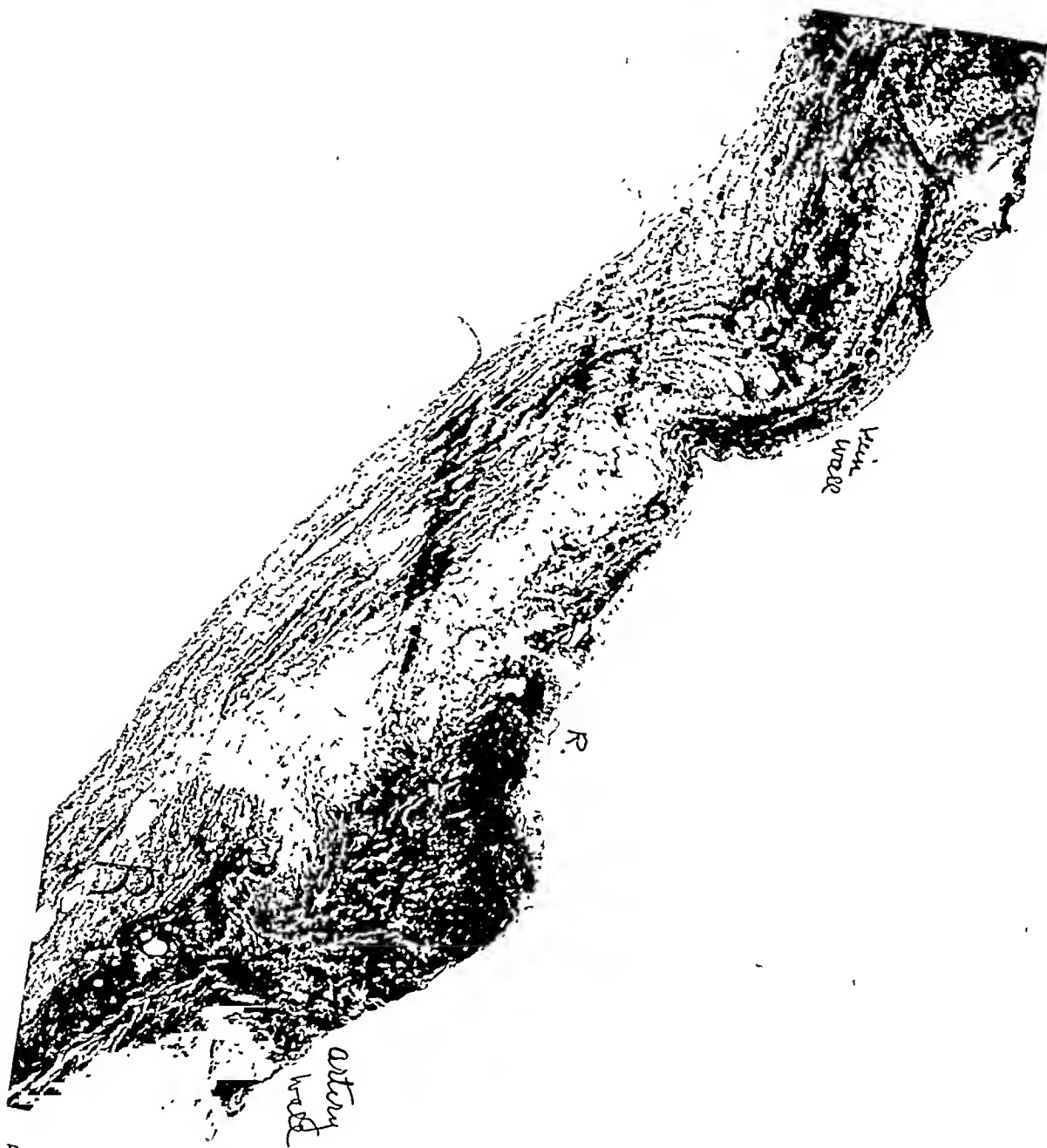


FIG. 7.—Photomicrograph, mag. 20. Autotransplantation of femoral vein to carotid. Eight days. Dog No. 268. Surg. Path. No. 2382. Space between artery wall and transplant is exceedingly small and made up of proliferating connective tissue. Surface of the transplant is undergoing some form of degeneration. Immediately beneath the wall of the transplant, active proliferation of connective tissue is seen. A suture in the intima is covered by fibrin and reparative connective-tissue cells. Elastic fibres in the transplant are separated into smaller bundles. The wall of the transplant is apparently undergoing degeneration.

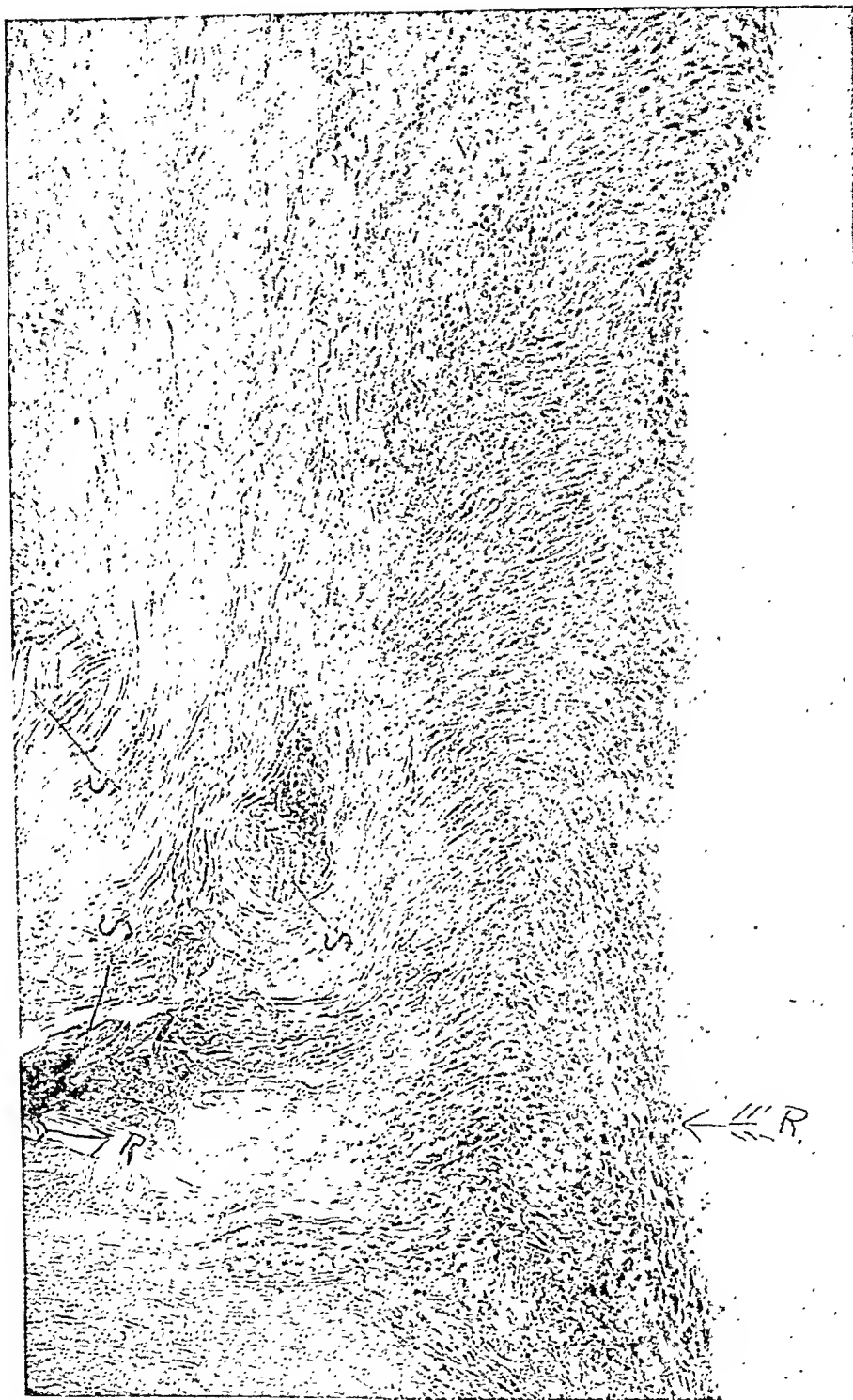


FIG. 10.—Photomicrograph, mag. 200. Autotransplantation of jugular to carotid. Two weeks. Dog No. 201. Surg. Path. No. 2340. Specimen removed January 31, 1913. Walls of the vessels are separated by about one millimetre. The interval is filled in by dense connective tissue. Scar tissue is somewhat irregular, but not covered by fibrin, except at one point. A uniform and regular layer of cells covers the cicatricial scar tissue.



FIG. 9.—Photomicrograph, mag. 415. Autotransplantation of vein into carotid. Surg. Path. No. 2283. Operation January 3. Specimen removed January 17. Vessel partially occluded by coagulum. Surface of coagulum presents connective-tissue cells and apparently no accretion has taken place. Blood coagulum covered by growing fibroblasts also infiltrating coagulum. No further tendency for blood to form a clot in the coagulum which presents a smooth surface as shown here.



FIG. 12 —Homotransplantation of femoral vein to jugular vein Surg Path. No. 2477. Operation April 11, 1913 Specimen removed April 18, 1913 Shows two valves in transplanted vein, one of which eneroaches upon suture line.



FIG. 11.—Photomicrograph, mag. 415. Autotransplantation of jugular to carotid. Two weeks. Dog No. 201. Surg. Path. No. 2340. Operation January 14, 1913. Specimen removed January 31, 1913. Walls of the vessels are separated by about one millimetre. The interval is filled in by dense connective tissue. Scar tissue is somewhat irregular but not covered by fibrin except at one point. A uniform and regular layer of cells covers the cicatricial scar tissue.

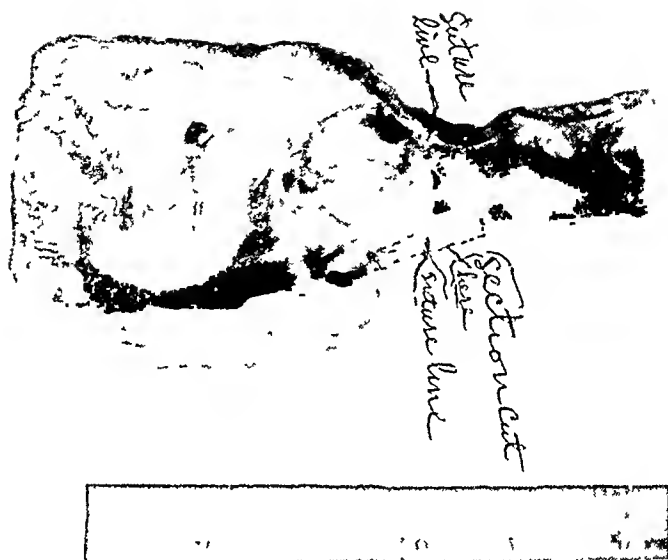


FIG. 14.—Arteriovenous anastomosis of femoral vessels. Male adult, aged thirty-five. Surg. Path. No. 3550.



FIG. 13.—Photomicrograph. Homotransplantation of femoral vein to the jugular. Dog No. 346. Surg. Path. No. 2477. Femoral vein transplanted from donor 178. Operation April 11, 1913. Specimen removed April 18, 1913. Complete union between transplant and jugular. Sutures are *in situ*. Accumulation of leucocytes about sutures. Intima smooth and even throughout. No formation of fibrin on intimal surface. Minute amount of connective tissue between apposed ends of vessels.







FIG. 15.—Photomicrograph, mag. 100. Arteriovenous anastomosis (human vessels). Surg. Path. No. 3550. The artery in close apposition with vein, especially in adventitia and media. Mass of connective tissue which has grown beneath the intima reinforces the junction. In the section at points the endothelium is intact. A thin layer of fibrin with a few round-cells in it is in the venous portion of the section.

jugular. Dog No. 346. Surg. Path. No. 2477. Femoral vein transplanted from donor 178. Operation April 11, 1913. Specimen removed April 18, 1913. Complete union between transplant and jugular. Sutures are *in situ*. Accumulation of leucocytes about sutures. Intima smooth and even throughout. No formation of fibrin on intimal surface. Minute amount of connective tissue between apposed ends of vessels.

*Case No. 11.*—Fig. 14. Arteriovenous anastomosis of femoral vessels. Male adult, age thirty-five. Surg. Path. No. 3550.

Fig. 15. Photomicrograph. Mag. 100. Arteriovenous anastomosis (human vessels). Surg. Path. No. 3550. The artery in close apposition with vein, especially in adventitia and media. Mass of connective tissue which has grown beneath the intima reinforces the junction. In the section at points, the endothelium is intact. A thin layer of fibrin with a few round-cells in it is in the venous portion of the section.

*Experiment No. 14.*—Homotransplantation of femoral artery to carotid. Dog No. 325 and Dog No. 294. Surg. Path. No. 2753. Shows a nice apposition of vessel ends with a minimum of cicatricial tissue with complete regeneration of intima. Operation March 7, 1913. Specimen removed March 21, 1913.

*Experiment No. 30.*—Homotransplantation of carotid. Three weeks. Dog No. 223 and Dog. No. 224. Surg. Path. No. 3529. Transplanted portion is undergoing degeneration though the coil of elastic lamina is still present but becoming fragmented. Elastic fibres can be seen in the degenerating portion. Beneath the adventitia of the transplant connective tissue is growing and infiltrating the adventitia. A minimum amount of cicatrix between transplant and original artery. Intima is intact. No functioning blood-vessels present in the transplant.

*Experiment No. 50.*—Homotransplantation of carotid to carotid. Surg. Path. No. 3526. Intima line of suture shows small dimple. Just beneath the lining cells a suture. Muscularis thrown up into a tent-like fold. In the connective tissue, outside of the muscularis several small deposits of chalk are seen. The adventitial line of suture shows considerable old blood pigment, several small round-cells and fibroblasts. No evidence of real bone formation.

*Experiment No. 53.*—Homotransplantation of carotid to carotid. Surg. Path. No. 3527. At the intimal side of suture line is thrown up a fibrinous plastic deposit. Muscularis on either side separated by considerable fibrous tissue. Suture line very irregular and shows much more connective tissue production than the others.

*Experiment No. 56.*—Homotransplantation of carotid to carotid. Surg. Path. No. 3528. Suture line shows usual indentation which is partially filled up by fibrin and blood clot. Just beneath this are seen large irregular masses of calcium. Beneath this the muscularis is apparently continuous. No break in the muscularis or evidence of fibrous union.

There is more or less unanimity of opinion in the manner of restoration of all the coats of the vessel excepting of the intima. Some believe that the surface connective tissue cells become adapted and form the lining endothelium, while the majority believe that the undamaged adjacent endothelial proliferation should cover the exposed connective tissue.

This latter conception is in accordance with the uniformly accepted

## CIRCULAR SUTURE OF BLOOD-VESSELS

*Experiment No. 35.*—Fig. 5. Side-to-side anastomosis. Jugularis externa and carotid. Surg. Path. No. 3861. Operation June 18, 1915. Specimen removed February 28, 1916.

Fig. 6. Photomicrograph. Side-to-side anastomosis between external jugular and carotid. Dog No. 386. Surg. Path. No. 3861. Operation June 18, 1915. Specimen removed February 28, 1916. Intimal surface joins intimal surface through the opening. Cicatricial tissue joins adventitia to adventitia adjacent to the opening. Sutures are well buried in the media and adventitia.

*Experiment No. 12.*—Fig. 7. Photomicrograph. Mag. 20. Autotransplant of femoral vein to carotid. Eight days. Dog No. 268. Surg. Path. No. 2382. Space between artery wall and transplant is exceedingly small and made up of proliferating connective tissue. Surface of the transplant is undergoing some form of degeneration. Immediately beneath the wall of the transplant, active proliferation of connective tissue is seen. A suture in the intima is covered by fibrin and reparative connective tissue cells. Elastic fibres in the transplant are separated into smaller bundles. The wall of the transplant is apparently undergoing degeneration.

Fig. 8. Photomicrograph. Mag. 300. Autotransplantation of femoral vein to carotid. Eight days. Dog No. 268. Surg. Path. No. 2382. Space between artery wall and transplant is exceedingly small and made up of proliferating connective tissue. Surface of the transplant is undergoing some form of degeneration. Immediately beneath the wall of the transplant, active proliferation of connective tissue is seen. A suture in the intima is covered by fibrin and reparative connective tissue cells. Elastic fibres in the transplant are separated into smaller bundles. The wall of the transplant is apparently undergoing degeneration.

*Experiment No. 5.*—Fig. 9. Photomicrograph. Mag. 415. Autotransplantation of vein into carotid. Surg. Path. No. 2283. Operation January 3. Specimen removed January 17. Vessel partially occluded by coagulum. Surface of coagulum presents connective tissue cells and apparently no accretion has taken place. Blood coagulum covered by growing fibroblasts also infiltrating coagulum. No further tendency for blood to form a clot in the coagulum which presents a smooth surface as shown here.

*Experiment No. 7.*—Fig. 10. Photomicrograph. Mag. 200. Autotransplantation of jugular to carotid. Two weeks. Dog No. 201. Surg. Path. No. 2340. Specimen removed January 31, 1913. Walls of the vessels are separated by about one millimetre. The interval is filled in by dense connective tissue. Scar tissue is somewhat irregular, but not covered by fibrin, except at one point. A uniform and regular layer of cells covers the cicatricial scar tissue.

Fig. 11. Photomicrograph. Mag. 415. Autotransplantation of jugular to carotid. Two weeks. Dog No. 201. Surg. Path. No. 2340. Operation, January 14, 1913. Specimen removed January 31, 1913. Walls of the vessels are separated by about one millimetre. The interval is filled in by dense connective tissue. Scar tissue is somewhat irregular but not covered by fibrin except at one point. A uniform and regular layer of cells covers the cicatricial scar tissue.

*Experiment No. 11.*—Fig. 12. Homotransplantation of femoral vein to jugular vein. Surg. Path. No. 2477. Operation April 11, 1913. Specimen removed April 18, 1913. Shows two valves in transplanted vein, one of which encroaches upon the suture line.

Fig. 13. Photomicrograph. Homotransplantation of femoral vein to the

suture posteriorly, a minimum amount of twisting of the vessels is brought about. This has been found of special importance in the suture of a shorter vessel (splenic and renal).

Autotransplantation and homotransplantation of segments of veins and arteries are perfectly practicable. While a tendency to degeneration of the transplant is indicated, the functional results of the transplant do not seem to be impaired.

In my opinion all transplanted tissue that degenerates sooner or later undergoes connective tissue infiltration, and becomes replaced by the tissue of the host. The transplant acts as a scaffold for the support of the connective tissue of the host.

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## CIRCULAR SUTURE OF BLOOD-VESSELS

interpretation of the repair and regeneration of epithelial defects in the skin and in the mucosæ where epithelium proliferates from the margins and covers the denuded area. It seems to be a question of specificity; of the epithelium it is recognized; of the endothelium, it is questioned.

H. von Schulte after extensive and exhaustive studies on the early stages of vasculogenesis in the cat makes deductions which seem to cast doubt upon the specificity of endothelium. He believes that endothelium may be adapted from connective tissue cells.

The recent studies of W. C. Clarke lend support to his deductions. Clarke holds that the following hypothesis premised in his article is tenable, that is, the surface cells of serous membranes and those lining blood-vessels may regenerate from deep connective tissue cells, and do not necessarily arise from adjacent intact mesothelial or endothelial cells.

Histological studies tend to demonstrate that in the absence of infection, even if the lines of the vessels are not evenly approximated, the chink will be filled in with blood clot. As long as this minute blood clot does not project into the lumen of the vessel there is no accretion and it does no harm. Fibrous connective tissue will grow in and organize the blood clot, and the cells which finally reach the surface will become competent as endothelial cells. In other words, a foreign body in blood-vessels, such as a suture if it is not contaminated, will not produce thrombosis. This may be observed in No. 3729, Fig. 3.

The following conclusions are the result of these studies:

The continuous circular suture with fine silk (vaselined or paraffined) penetrating the media and intima is thoroughly practicable and of ready application.

The circular suture restores the continuity of the vessel without impairing the integrity of its walls or diminishing its lumen.

Side-to-side anastomosis between an artery and a vein can be readily accomplished without the formation of thrombosis.

Fusion of the approximated ends of the vessels takes place by connective-tissue proliferation.

A slight bulging at the suture line does not seem in any way to interfere with the functional efficiency of the vessel, as is shown in two of the specimens.

In the absence of infection, sutures penetrating the intima and entering the lumen of the vessel will do no harm. Connective tissue will grow in and cover the sutures. The cells covering the suture line may become flattened and functionate eventually as endothelial cells, or, as many believe, the connective tissue is covered by proliferating endothelium.

In end-to-end anastomosis, by the introduction of one retaining

# STUDIES IN REGENERATION AND GROWTH OF BONE\*

THE DEMONSTRATION OF NEW FORMED BONE BY INTRAVITAL STAINING

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THE accurate knowledge of the process of growth and regeneration of bone is of very great importance in the treatment of all diseases of bones and especially in those conditions in which plastic bone surgery is indicated. A large amount of experimental work has been done on this subject and there is yet a difference of opinion concerning the osteogenetic properties of the different elements of bone. This is especially true as regards the osteogenetic properties of the different elements of the free bone transplant.

This difference of opinion may be due to the unsatisfactory methods which have been used in experimental study. Examination of the specimens from experiments by dissection or by means of the Röntgen rays does not reveal small changes. Microscopic study is unsatisfactory because it is often impossible to distinguish between the process of new bone formation and the process of bone absorption. A method which would make it possible for the investigator to distinguish the new bone which has formed in any given length of time would be valuable in the study of many of the problems of the growth and regeneration of bone.

In 1736 John Belchier,<sup>1</sup> an English surgeon, called attention to the fact that the bones of animals which had been fed on madder root (*Rubia tinctorum*) were colored red. Beckman<sup>2</sup> cited evidence that this fact was probably known to the ancients. During the period 1739 to 1760, several investigators, du Hamel,<sup>3</sup> Haller,<sup>4</sup> Bordenave,<sup>5</sup> Fougereux,<sup>6</sup> Dethlef,<sup>7</sup> and others used this method in many experiments to study the growth and regeneration of bones, and recorded much fundamental knowledge, full credit for which is not found in modern literature. All of these investigators knew that it was only the bone which was formed during the ingestion of the madder which was colored,

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\* Read before the Washington University Society, January 8, 1917.

## CIRCULAR SUTURE OF BLOOD-VESSELS

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FIG. 1

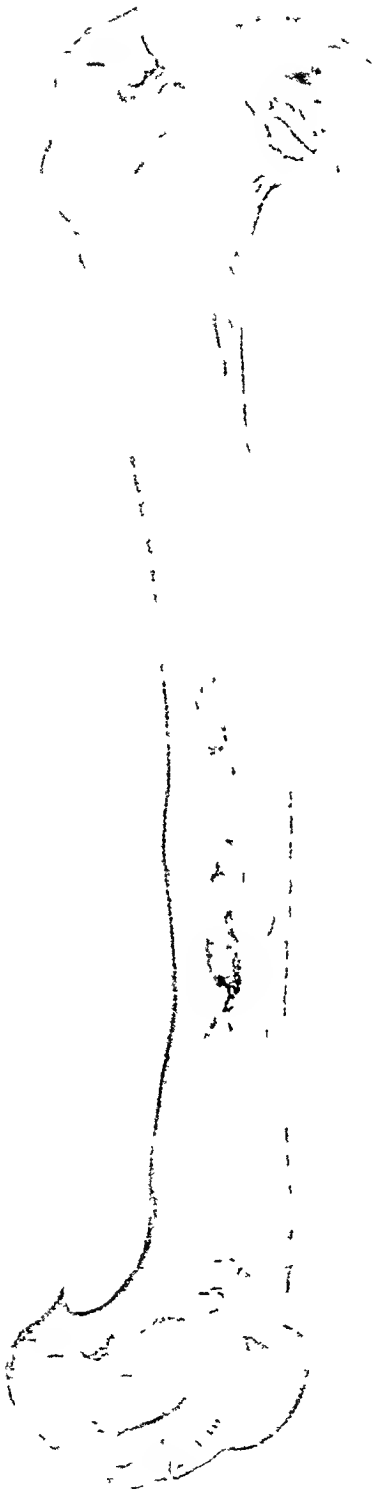


FIG. 3



FIG. 1.—Experiment No. 1. Femur of a dog. Strip of bone was removed. The animal was then fed madder for seventeen days. Note the pink color to the new bone formed in the defect and about its margin.

FIG. 2.—Experiment No. 1. Cross-section of femur shown in Fig. 1.

FIG. 3 —Experiment No. 2. Ulna of rabbit fourteen days after fracture. Animal fed sodium alzarine sulphonate. Note the new bone formed in the callus and along the shaft is colored red. The original bone shaft and the cartilaginous portion of the callus are unstained.

amount given. The method was discontinued on account of much more satisfactory results being obtained by the use of sodium alizarine sulphonate.

## 2. EXPERIMENTS WITH ALIZARINE AND SODIUM ALIZARINE SULPHONATE

As previously stated, the color bearing substance in madder is a derivative of alizarine. Alizarine was tried in a single experiment in which it was fed to a rabbit with an experimental fracture for a period of eleven days. The new bone formed was not colored. Alizarine is a very insoluble substance and it may be that it is not absorbed from the intestinal canal. The soluble alizarine derivative, sodium alizarine sulphonate, was used in the following experiments:

*Experiment No. 2.*—October 30, 1916. Rabbit.

Ether anæsthesia. Both bones of the left foreleg fractured. The animal was fed on a mixture of rolled oats and sodium alizarine sulphonate. To each 100 grammes of rolled oats was added 5 grammes sodium alizarine sulphonate. A constant supply of the mixture was kept in the animal's cage. Owing to frequent soiling of the food supply, the actual amount of the dye ingested was not determined.

November 13, 1916. Fourteen days. The animal remained in good condition. Sacrificed.

*Autopsy.*—The bones other than those of the left foreleg appeared quite normal. The fractured bones were firmly united by callus. The entire shafts of both bones from the exterior were colored dark red. The callus immediately at the fracture was mottled red and white. On section of the bones the red color was confined to a layer of new formed bone under the periosteum and to the ossified areas in the cartilaginous callus. The original shafts of the bones and the cartilaginous portion of the callus were normal color (see Fig. 3).

*Experiment No. 3.*—November 14, 1916. Rabbit.

Ether anæsthesia. Both bones of right foreleg fractured. Animal given daily 1 c.c. of one-half saturated aqueous solution sodium alizarine sulphonate, subcutaneously.

November 23, 1916. Nine days. Animal in good condition. Slight induration about some points of subcutaneous injection. Sacrificed.

*Autopsy.*—The bones of the extremities were removed and cleaned partially of soft parts and placed in formalin. When the color due to blood had faded, the bones were cleaned. The bones other than those fractured were normal in appearance. The fractured bones were united by firm callus. The entire shafts of both bones were a bright violet-red color on the outside surfaces. The callus was partially ossified. The ossified areas were stained. The cartilage was unstained. On section of the bones the color was confined to a layer of new bone formed under the periosteum. The original shafts of the bones were unstained. In the callus were fragments of bone. These fragments were unstained, but the new bone formed about the fragments was colored (see Fig. 4).

## REGENERATION AND GROWTH OF BONE

but it was James Paget<sup>8</sup> who first emphasized this point. This author writes of experiments with madder:

"Experiments with madder root afford the observer a means, as it were, of branding with his own mark every particle of phosphate of lime deposited in a given time."

Kölliker,<sup>9</sup> Strelzoff,<sup>10</sup> and Ollier<sup>11</sup> used madder to color bones in living animals, but this method has not been used in any of the recent experimental work. Shipley and Macklin<sup>12</sup> briefly describe the use of trypan blue as a method of staining areas of "osteoblastic activity." The color bearing substance of madder is a glucoside of alizarine, and alizarine has been used by Spalteholz as a post-mortem stain for bone.

The following experiments were done in order to test the properties of madder root, alizarine, and sodium alizarine sulphonate as regards vital staining of bone. The animals used were dogs and rabbits. All operations were done with complete ether anæsthesia and open operations were done with the usual precautions against wound infection.

### I. EXPERIMENT WITH MADDER

The substance used was "Dutch madder," and was said to be the madder root dried and ground. It was a fine red powder.

*Experiment No. 1.*—November 6, 1916. Adult dog. Weight, 10 K.

Ether anæsthesia. Shaft of femur exposed. With a motor saw, a strip of bone 2 mm. wide and 4 cm. long was excised from the full thickness of the cortex of the shaft of the femur. Wound closed.

The animal was fed 20 grammes of powdered madder root daily in a thick soup with meat, for seventeen days.

November 23, 1916. Animal sacrificed. The femur from which the strip of bone was excised shows the defect filled with new formed bone. There is an area of subperiosteal new bone about the margins of the defect. The new formed bone which has filled the defect and that formed under the periosteum about the margins of the defect is a pale rose pink color. The remainder of the bone and the other bones in the body are normal in color (see Fig. 1). On cross-section of the femur the differentiation of the new formed bone is even more striking (see Fig. 2).

This experiment confirms the observations of the previous investigators on the results of feeding madder to animals with growing bone tissue. The bone which formed during the ingestion of the dye was stained and that which had been previously formed preserved its normal color. The color obtained in our experiments was quite faint. This may be due to the inferior quality of the madder root or the small

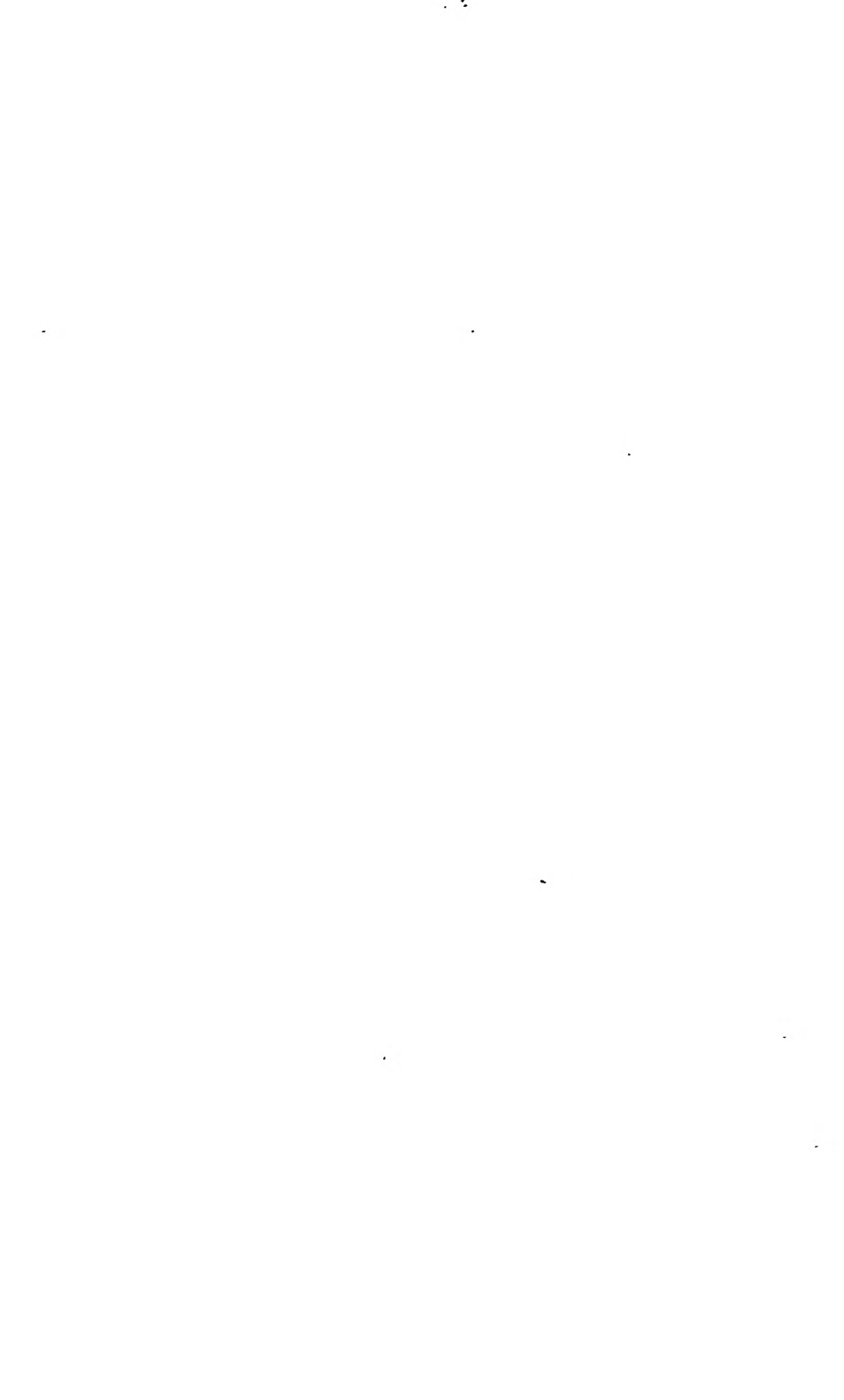


FIG. 4

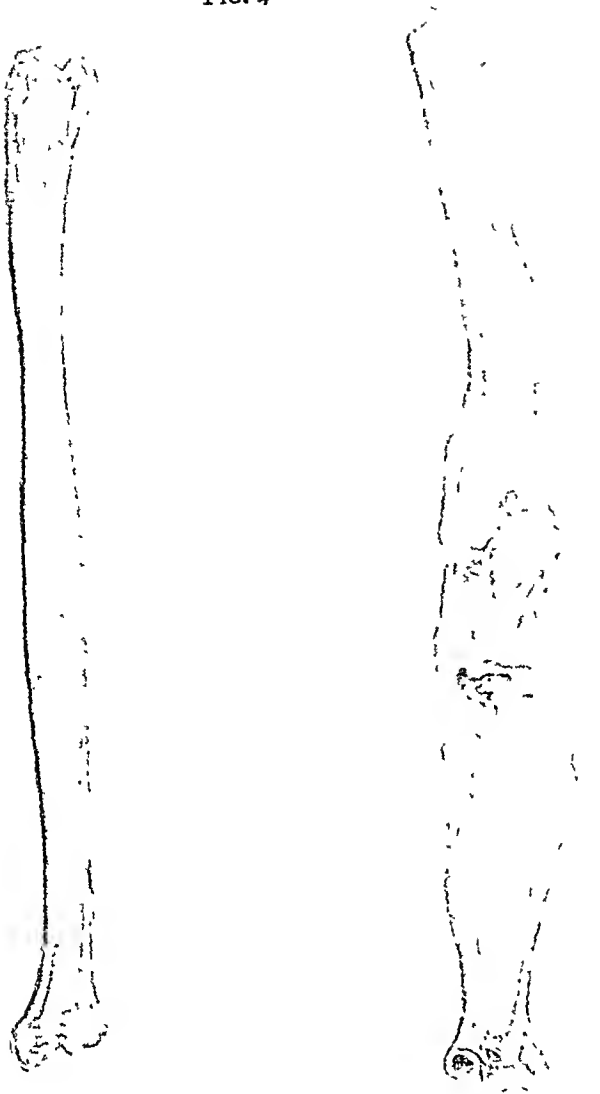


FIG. 5

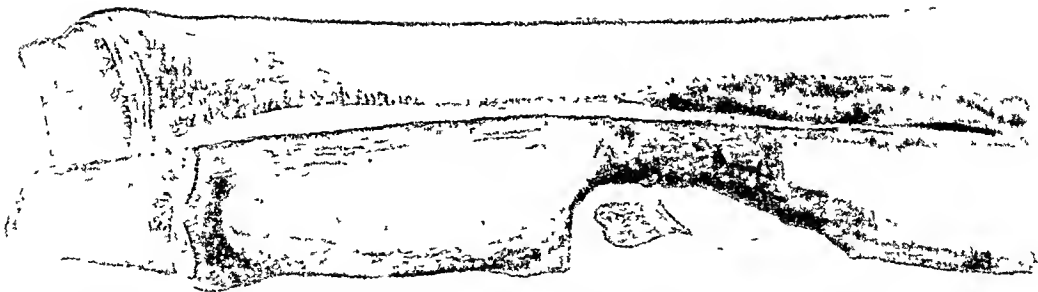


FIG. 4.—Experiment No. 3. Radius of rabbit nine days after fracture, and the radius of the opposite side. Animal given sodium alizarine sulphonate subcutaneously. Note the new bone formed along the shaft and from the bone fragment in the callus is colored. The radius of uninjured leg is unstained.

FIG. 5.—Experiment No. 5. Bones of foreleg of young rabbit sixteen days after subperiosteal resection of a portion of the ulna. Animal given sodium alizarine sulphonate subcutaneously. Note the red color of the new bone formed in the defect and the coloring of the bone at the epiphysial cartilages.

intervenes between the proximal epiphysial line and the shaft. The styloid process of the ulna was colored at the tip. The epiphyses were otherwise uncolored.

*Experiment No. 7.*—December 19, 1916. Rabbit.

Ether anæsthesia. Fracture of the right ulna. The animal was allowed to live for thirteen days; no sodium alizarine sulphonate being given. On the beginning of the fourteenth day, 5 c.c. of a saturated aqueous solution of sodium alizarine sulphonate was given subcutaneously. The animal was sacrificed on the following day.

Examination of the bones showed a narrow zone of color on the diaphysial sides of the epiphysial cartilages. The fractured bone fragments were united by a firm callus which was almost completely ossified. The new formed bone of the callus was colored irregularly. The new bone at the junction of the callus and the shaft was colored very faintly or not at all. The new bone in the middle of the callus was vividly stained. The bone which was not stained was at the site where new bone is first formed (see Fig. 7). The remainder of the bone and the other bones of the body were normal in color except at the epiphysial lines.

These experiments show that sodium alizarine sulphonate, when given by mouth, subcutaneously, or intravenously, has selective intravital staining properties for new formed bone. In Experiment No. 4, in which large doses of the dye were given intravenously to an adult rabbit for three days, there was no staining of the bones during life. In Experiments Nos. 2 and 3, it was only the new bone formed in response to injury which was colored. In Experiment No. 6, in which there was no injury, there was staining of the bone at the sites at which the normal growth of bone occurs. In Experiment No. 5, the new bone formed in response to injury and that formed in the normal growth of the animal was colored.

Experiment No. 7 is particularly interesting. It shows that it is not only the bone which is actually formed during the time the dye is in the circulation which is stained, but that also the bone which has been recently laid down is colored. The formation of new bone in experimental fractures in rabbits begins about the fourth day. In this experiment the new bone formed during the first few days of actual bone production remained uncolored. It would seem, therefore, that a single injection of the dye would stain all new bone formed in response to injury, during a period approximately a week previous to the injection. Further investigation is needed to substantiate this conclusion, but, in other experiments, injection of the dye once each week has seemed to color all the new bone formed during periods as long as a month. This experiment indicates that the statement of Paget, that madder stains only bone which is formed during the period

## REGENERATION AND GROWTH OF BONE

*Experiment No. 4.*—November 14, 1916. Rabbit.

Ether anæsthesia. Both bones of right foreleg fractured. Animal given 1 c.c. of a saturated aqueous solution of sodium alizarine sulphonate intravenously in marginal ear vein. The injection was repeated on the two following days.

November 17, 1916. Animal found dead.

*Autopsy.*—The bones of the extremities were removed. No visible coloring of exterior of bones. No callus at site of fracture. No evidence of new bone formation. No color. The bones were placed in formalin and when sectioned a few days later, there was seen a faint pink in the marrow canal. This coloring was probably due to post-mortem staining of the bone from the dye in the blood serum. No color observed where the soft parts were not left in contact with the bone.

*Experiment No. 5.*—November 25, 1916. Rabbit.

Ether anæsthesia. Incision in foreleg. Subperiosteal resection of 1 cm. of ulna. Wound closed.

November 29, 1916. Animal given 1 c.c. saturated aqueous sodium sulphonate intravenously.

December 11, 1916. Sixteen days. Animal has had daily 2 c.c. saturated aqueous solution sodium alizarine sulphonate subcutaneously. Sacrificed.

*Autopsy.*—There was regeneration of a bone bridge across the defect in the resected ulna. The bone filling the defect was stained a deep violet red color. There was subperiosteal new bone formation along the shaft of the stump of the ulna. There was some new bone formation on the radius in the region of the resection of the ulna. All new formed bone was deeply stained. The preformed bone was unstained. The other bones of the extremities showed an irregular mottling of the outside surfaces of the shafts. There was a thin layer of color irregularly distributed on the wall of the medullary canal. At the epiphysial lines there was very marked staining. There was a very narrow line of color on the epiphysial side of the cartilage and wider deeper stained zone on the diaphysial side. The epiphysis showed only slight coloring (see Fig. 5).

*Experiment No. 6.*—November 20, 1916. Dog.

A young dog was given daily a subcutaneous injection of 2 c.c. of a saturated aqueous solution of sodium alizarine sulphonate for seven days. The injection of the dye resulted in the formation of several subcutaneous abscesses, and the animal lost considerable weight during the experiment. On examination of the bones it was found that the epiphyses were not united to the shafts. A description of the coloring of the radius and ulna will exemplify the coloring of all the bones in the body. The shafts of the bones were faintly stained on the external surface. The color was more marked near the epiphysial lines. On section of the bones, the color was confined to a thin layer of bone next to the periosteum. The remainder of the thickness of the bone was unstained. There was a marked zone of color on the diaphysial side of each epiphysial cartilage of the radius and on the diaphysial side of the distal epiphysial cartilage of the ulna (see Fig. 6). This is of particular significance when it is appreciated that the length of the forearm is increased by the growth of bone at both epiphysial lines in the radius, while the ulna can increase the length of the forearm only from growth at the distal epiphysial line, since the joint







FIG 6 —Experiment No. 6. Radius and ulna of a young dog. Sodium alizarine sulphonate given subcutaneously seven days. Note the coloring of bone at both epiphysial lines of radius and at only the distal epiphysial line of the ulna.

FIG. 7.—Experiment No. 7. Ulna of rabbit fourteen days after fracture. Single subcutaneous injection of sodium alizarine sulphonate on fourteenth day. Note staining of new bone in callus. The bone formed at X is uncolored.

genetic properties of the free bone transplant will be reported in a later paper.

These experiments show that sodium alizarine sulphonate when given by mouth, subcutaneously or intravenously has selective intravital staining properties, and that it stains only bone which has been but recently formed or is formed during the period the dye is in the circulation.

The use of sodium alizarine sulphonate experimentally furnishes a valuable method in the study of the problems of regeneration and growth of bone.

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- <sup>3</sup> Du Hamel: *Histoire de l'Acad. des Sc.*, 1739, 1741, 1742, 1743.
- <sup>4</sup> Haller: *Elementa physiologiæ corporis humani*. Lausannæ, Bonsquet, 1757-1764.
- <sup>5</sup> Bordenave: See Fougereux.
- <sup>6</sup> Fougereux: *Memoirs sur les os*. Paris, 1760.
- <sup>7</sup> Dethlef: Haller's *Opera Minora*, vol. ii.
- <sup>8</sup> Paget: *London Medical Gazette*, 1839, vol. i, p. 277.
- <sup>9</sup> Kölliker: *Verhand d. phys. med. gesellsch. Würzburg*, 1873, Bd. v.
- <sup>10</sup> Strelzoff: *Arch. f. Mik. Anat.*, 1875, Bd. xi, p. 33.
- <sup>11</sup> Ollier: *Regeneration des Os*. Paris, 1867.
- <sup>12</sup> Shipley and Macklin: *Anat. Record*, 1916, vol. x, p. 597.

## REGENERATION AND GROWTH OF BONE

in which the dye is given, could not be applied absolutely to the use of sodium alizarine sulphonate..

In Experiment No. 6, it was found that the subcutaneous injection of the saturated solution of the dye led to the formation of abscesses at the site of injection. This has occurred in all cases in which dogs have been given the dye subcutaneously. It has not occurred in similar administration to rabbits. In later experiments with dogs more satisfactory results have been obtained by using a more dilute solution and injecting it intraperitoneally. It has also been found that feeding sodium alizarine sulphonate to dogs has resulted in relatively faint staining of the bone, while the same method of administration to rabbits has stained the new formed bone very vividly. It is interesting that the color obtained in the new formed bone in those cases in which the dye was given by mouth was different from that seen in the new bone formed during the administration of the dye subcutaneously. In the former case the color is a brick red; in the latter, a violet-red.

The color in the new bone tissue is more striking after the tissue has been in formalin for twenty-four hours, and the normal blood color of the tissues has faded. The colored bone tissue fades slowly in formalin but rapidly when the specimen is allowed to dry. The color is entirely removed when the bone is decalcified. The color in the bone is probably due to a chemical combination between the dye and the calcium salts of the bone. In one experiment in which the dye was being given there was degeneration and calcification of muscle. The calcified areas in the muscle were colored red. No other tissue in the body has been observed to be stained. The selection of the dye for new formed bone must be due to the fact that the calcium salts in new formed bone are in such a state that chemical combination between the calcium salts and the dye can take place. Whether the calcium salts in bone which has been deposited for a longer time are prevented from combination with the color-bearing substance in the blood stream by being surrounded by impermeable material or whether the fully developed bone tissue does not color because the calcium salts in such tissue are in such chemical state that combination with the dye does not take place, is not clear. That it is not merely a matter of vascularity is shown by the fact that cancellous bone does not stain any more readily than dense cortical bone. That the combination with the dye does take place even after the calcium salts have been taken out of the blood stream is shown by Experiment No. 7, in which there was staining of bone tissue formed previous to the injection of the dye.

The results of the application of this method of study of the osteo-

Thirty years after Heister, Winslow<sup>5</sup> fell into the same error, but stated that one might easily mistake the glands for little fat masses. It remained for Bichat,<sup>6</sup> in his general anatomy of 1801, to finally recognize this pad as consisting of adipose tissue, which has ever since been recognized by French anatomists as *la boule graisseuse de Bichat*.

Probably Tillaux,<sup>7</sup> better than any regional anatomist, has depicted in the clearest way (Fig. 3) this fat pad, which he described as follows: Between the buccinator muscle and its aponeurosis there is a constant fat ball, even in the most emaciated subjects. It corresponds to the anterior border of the ascending ramus of the jaw, in relation with the anterior border, and a little on the inner surface of the masseter muscle, which it separates from the buccinator. The cheek presents therefore two layers of fat, which are distinct from each other. The one superficial, subcutaneous above the fascia, the other deep seated and beneath the fascia. The first layer is continuous with the subcutaneous adipose tissue of the temporal and parotid regions. The second is continuous with the fat of the zygomatic fossa, and through it with the subaponeurotic layer of the temporal region and of the floor of the parotid niche. In many subjects this little ball of fat is loosely surrounded by a thin capsule, through which it can be, as Bichat first showed, lifted out of the pocket in which it is contained.

A very interesting study of this little fat mass was made by Ranke,<sup>8</sup> who discovered it already well formed in the foetus as early as the fourth month. He recognized its covering with the special capsule and described particularly a prolongation, likewise covered by a capsule, which is projected into the sphenopalatine fossa, and gives at times a pedunculated appearance to the little ball of fat. All writers agree that the suction pad is separate and distinct from the general subcutaneous adipose layer.

In 1853, Gehewe,<sup>9</sup> in a long forgotten thesis, came to the conclusion that the function of this fat pad differs from that of fat in general, and believed that in a mechanical way it aided the act of sucking, in that, since the buccinator muscle in the new-born is still very feeble, the fat pad by its outer attachments prevents the indrawing of the cheek while nursing.

Fatty tumors of the cheek were, so far as I know, first mentioned by Bruns,<sup>10</sup> who collected four cases. He called attention to the ease with which the growth might be mistaken for a parotid tumor. Two cases of lipoma of the cheek are contained in the statistics of Stoll,<sup>11</sup> one of which probably sprang from the fat pad under consideration. A case was reported by Villars<sup>12</sup> to the French Academy in 1888, and in his

# CONGENITAL LIPOMATA OF THE CHEEK

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CONGENITAL tumors in the restricted use of the word are rare, and rarest of them all are the lipomata. In 1884, Jacobi<sup>1</sup> collected twenty-nine cases of the latter from the literature extending over a century. Many of the cases were not clean lipomata, but associated with lymph-ectasis, causing a localized gigantism. There must also be excluded from the congenital lipomata those cases in which the lipoma is only an addendum to some congenital deformity like spina bifida, with which it is not infrequently associated, or with the various teratomata as they occur, chiefly about the sacrum and coccyx. Morestin,<sup>2</sup> in reporting a congenital lipoma of the calf, quotes a thesis of Malacon, who was enabled to collect only twelve examples of congenital lipoma.

Of seventy-three cases of lipoma observed by Billroth,<sup>3</sup> in Zurich and Vienna, only one was congenital. It was on the dorsum of the foot. Lipomata of the cheek have been described by a number of authors, but very few have been seen sufficiently early in life to be indubitably congenital.

Perhaps the most interesting subject connected with fatty tumors of the cheek is the history of our knowledge of a little mass of fat, situated on and adherent to the outer surface of the buccinator muscle. It exists before birth and continues throughout life, and does not disappear even in extreme emaciation. Since from its function it may properly be called the sucking cushion or pad, it may be considered an anatomic proof that man never ceases to be a sucker, no matter what his age.

English and German anatomies refer but briefly to this fat pad. Like so many other things in medicine it was discovered and forgotten a number of times. It is probable that it was first recognized as a distinct entity by Heister,<sup>4</sup> in 1732, who described its shape and relations very accurately, but believed it to be of a glandular nature, probably on account of its proximity to the molar muciparous glands. Fig. 1 is a reproduction of Heister's copperplate of the fat pad, and Fig. 2, likewise reproduced from the original engraving of Heister, shows the lobulated contour of the fat pad, which doubtless led him to believe it to be of glandular origin. This figure is particularly interesting, in that it apparently shows two lobules into which the fat mass is often divided by the passage of the terminal part of the parotid duct.



fig 36.

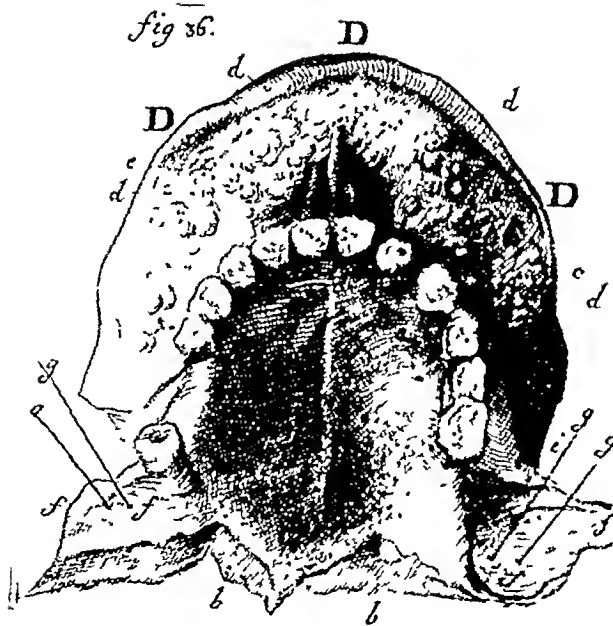


FIG. 1.—gg, fat pad.

fig: 32.



FIG 2.

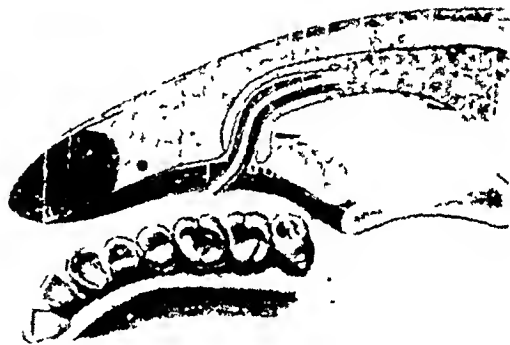


FIG 3.

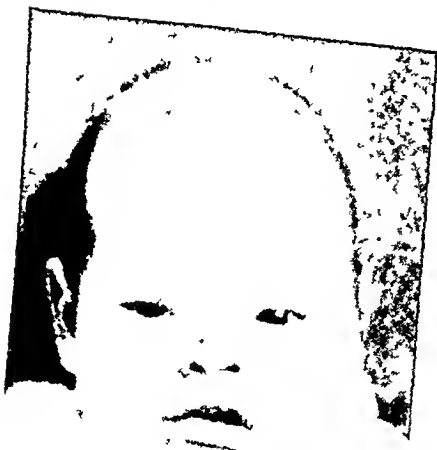


FIG 4



FIG. 5.



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- <sup>12</sup> Villars: Bull. de la Soc. Anat., 1888, p. 954.
- <sup>13</sup> Virchow: Geschwulstlehre, vol. i.
- <sup>14</sup> Gant: Lancet, 1856, vol. ii, p. 620.
- <sup>15</sup> Mathias: Lancet, 1863, vol. i, p. 692.
- <sup>16</sup> Butlin: St. Barthol. Hosp. Repts., vol. xiii, p. 180.

article he refers to ten other lipomata of the face, the descriptions of which, however, are very brief, and it must be questioned whether they belong to the deep-seated group springing from the fat pad of Bichat. None of these cases were distinctly congenital.

Virchow<sup>13</sup> in his classic work on tumors refers to a single example contained in his collection. Gant<sup>14</sup> and Mathias<sup>15</sup> have reported cases in the *Lancet*. They are the only cases which I have been enabled to find in the English literature. I am perhaps fortunate, therefore, in being enabled to present two cases, congenital in nature, that have been under my care, with an interval of over twenty years between them.

The first was a little girl of six months (Fig. 4), who from the time of her birth had a large swelling of the left cheek, which grew rather rapidly. On examination there is a tumor as large as a small peach, involving the thickness of the left cheek. It extended from near the ear to the angle of the mouth. On bimanual examination from within, an intrabuccal projection could be felt. The skin could easily be moved over it. The surface of the tumor was lobulated and there was a sense of fluctuation in it. The operation, done from without, revealed a lipoma, which in places had undergone a myxomatous degeneration.

The second case (Fig. 5) was of a little girl, five years old, who was operated upon in Russia, where at the age of one year a tumor was removed through an incision made near and parallel to the margin of the lower jaw. Examination revealed the presence of a uniform swelling of the left cheek, extending from the zygoma to the angle of the mouth. This was very much depressed. Between the dental arches the tumor mass projected as a roll, about the shape and size of an adult thumb. Skin and mucosa were easily moved over the swelling which was of firm consistence and of even surface. An attempt to remove the growth through the old incision failed, so that an enucleation through the mouth was done. The tumor could not be removed in one mass, but was removed piecemeal. The pathologist reports that for a lipoma, there was an unusual development of fibrous and lymph-angiomatous tissue, much in excess of what is found around or within the capsule of the ordinary lipoma. This is interesting in view of an observation first made by Butlin<sup>16</sup> in connection with the report of a congenital lipoma removed from the calf of the leg. It is that the congenital lipoma nearly always presents a greater admixture of fibrous tissue than the acquired lipoma, and that very often, as was stated in the beginning of this article, they are associated with conditions of lymphangiectasis.

phatics of the superior cervical triangle, the submaxillary gland, part of the floor of the mouth, and all of the left half of the inferior maxilla as far back as the angle. The mouth wound was entirely closed and the defect packed with iodoform gauze, down to which the platysma and skin were sutured.

The gauze pack was removed on the fourth day; the wound drained freely, and for six days required dressings four times a day. The following few days only two changes were necessary, and during two days before the patient was discharged, the wound required but one dressing. Dry sterile gauze was used throughout. The discharge, at first, was seromucous tinged with blood, but, after three days, it became mucopurulent with an admixture of food particles, continuing so for five days, after which no more were noted, but the discharge retained its purulent character as long as the patient remained in the hospital. The stitches were removed on the tenth day. The suture line in the skin had been reddened and swollen for three previous days, but pure glycerin packs aided the wound to close perfectly. The wound inside of the mouth was kept as clean as possible with an alkaline mouth-wash, which the patient used at least four times during the day.

On the twelfth post-operative day, the man was discharged, the incision inside the mouth being apparently healed, as was also the skin incision, excepting an area 3 cm. long, and 2 cm. wide, through which the neck wound had been packed. It was still open, and led into a pyramidal cavity, the base situated at the opening in the skin incision, the apex extended deep into the neck and toward the lobe of the ear. Its sides were composed of sloughing tissue and granulations, from which came the discharge. The general health had become very good, and the blood-pressure was the same as when first admitted; as the further post-operative course promised to be uneventful, the future treatment was entrusted to the patient's family doctor.

He had remained at home not more than thirty-six hours, when he was awakened at 3 A.M., December 12, 1915, by a profuse hemorrhage from his neck and mouth. His wife estimated the blood at one quart. When seen by Dr. Bartlett at 11 A.M., he was pale, anxious, and uncomfortable. The pulse was small and rapid. He was at once returned to the hospital and put to bed.

The blood-pressure, taken immediately, was 127 systolic, 60 diastolic. Pulse was 80, respirations 24, temperature 98, hæmoglobin 85 per cent. The patient was kept at absolute bed rest, all visitors were denied, morphine gr.  $\frac{1}{4}$  (hypo.), given morning and night, and every effort made to keep him from getting excited.

The wound was irrigated twice each day with 95 per cent. ethyl alcohol, in an attempt to prevent further sloughing of the

# A STUDY OF SECONDARY HEMORRHAGE TREATED BY LIGATION OF THE COMMON CAROTID ARTERY

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ONE of the most dangerous accidents which ever complicates a surgical case is secondary hemorrhage from an infected wound communicating with the cavity of the mouth, or from an infected cervical defect out of which the lymph-glands and connecting lymphatics have been taken, as is done in removing a malignant tumor from the jaw, floor of the mouth, or the tongue. Such a high mortality has followed this accident that the recital of the history of the following successful case may be of value, and the means which effected the patient's rescue may, if imitated, be productive of similar happy results in other instances.

REPORT OF CASE.—H. S., a white male, aged fifty-four years, was admitted to St. Anthony's Hospital, November 24, 1915, on account of a tumor of the left lower jaw. He was a perfect specimen of manhood with no abnormalities, excepting the lesion in the mouth. The gum at the site of the bicuspid on the lower left jaw is the seat of a sloughing tumor, size of a small pecan (if it were whole), and extends towards the floor of the mouth. No glands or extensions palpated or seen. There is an area of leucoplakia surrounding it posteriorly. The breath is foul and many teeth are missing. Only the two lower central and lateral incisors, upper and lower first molars on each side are present. All are decayed and surrounded at the base by a soft, spongy gum from which pus is expressed at will.

On November 29, Dr. Bartlett operated for the removal of the growth. Anæsthetic: Ether, intrapharyngeal. The intra-tracheal method, which had been chosen, was abandoned, since the tube proved such a hindrance to the operator, but instead, one No. 18 male catheter was inserted into each nostril down to the pharynx, the catheters being connected with a bottle containing ether through which air was pumped into the lungs by means of a foot bellows.

Through a Kocher incision down the middle of the chin and well under the jaw-bone, were removed in one piece the lym-

December 20, 1915..systolic, 140; diastolic, 75; hæmoglobin, 60; Tallquist.  
 December 21, 1915..systolic, 140; diastolic, 78; hæmoglobin, 60; Tallquist.  
 December 22, 1915..systolic, 130; diastolic, 70; hæmoglobin, 60; Tallquist.  
 December 23, 1915..systolic, 125; diastolic, 75; hæmoglobin, 60; Tallquist.  
 December 24, 1915..systolic, 120; diastolic, 75; hæmoglobin, 65; Tallquist.  
 December 25, 1915..systolic, 120; diastolic, 80; hæmoglobin, 65; Tallquist.  
 December 26, 1915..systolic, 123; diastolic, 78; hæmoglobin, 70; Tallquist.  
 December 27, 1915..systolic, 125; diastolic, 80; hæmoglobin, 70; Tallquist.  
 December 28, 1915..systolic, 120; diastolic, 75; hæmoglobin, 70; Tallquist.  
 December 29, 1915..systolic, 115; diastolic, 75; hæmoglobin, 75; Tallquist.

The sudden rise of systolic blood-pressure from 80 to 140, and of diastolic from 55 to 75, after carotid ligation, illustrates most strikingly an interesting physiological point, viz.: the sudden damming of any large arterial trunk is followed at once by a marked rise in general blood-pressure, which is to be interpreted as a compensatory effort to supply the ischæmia area by dilating the collaterals. In this instance, nine days were required for the reëstablishment of the normal blood-pressure status, systolic 115, diastolic 75, which had obtained prior to the original operation. No doubt, the collaterals had by this time assumed to a sufficient degree the rôle formerly played by the common carotid. The hæmoglobin, however, while it steadily gained, never did reach its former percentage, in the hospital.

Water was given every two hours, 250 c.c. at a time. The appetite having returned, patient enjoyed the soft diet which was given every three hours, and in addition, large quantities of carrots, spinach, and red meats were consumed. The mastication of the food by this time was accomplished without any difficulty, and the right inferior maxilla retained approximately its normal position without any support save an ordinary face bandage.

At the end of the week, the stitches were removed, the ligation wound healing by first intention, despite the fact that the drainage from the high neck wound had flowed over it for more than a week. Infection of the new wound was prevented by colloidin dressings and special attention given to the draining wound.

The pack was removed after the third day, and each day iodoform gauze was reinserted until at the end of ten days, when the granulations had filled the wound to the skin edges and packing was very slight indeed. Two hours after the artery had been tied, the patient complained of a dull headache which disappeared in eighteen hours never to return. Eight hours following the operation, the right hand became numb and felt as though it were asleep. This sensation lasted only one hour, but returned after twenty-four hours, and remained with the patient thirty minutes.

## LIGATION OF THE COMMON CAROTID ARTERY

granulating wound inside the neck. Otherwise, the patient was accorded the treatment which he received when previously in the hospital.

For four days he did nicely. The discharge had diminished one-half, the blood-pressure had steadily fallen to 100 systolic, 65 diastolic, and the hæmoglobin 80 per cent. He was feeling so well that he was anxious to get out of bed and said that further stay there was making him nervous. The next morning at 2 A.M., December 12, 1915, after a good sleep the fore part of the night, he was awakened by a sudden gush of blood from his mouth and from the granulating wound inside the neck, and in less than two minutes, between 400 and 500 c.c. of arterial blood had been lost. The hemorrhage was stopped by compressing the common carotid artery between the thumb and the carotid tubercle, on the transverse process of the sixth cervical vertebra. This is directly in a horizontal line drawn parallel with the cricoid cartilage, and the common carotid artery, lying on it, is easily found.

Immediately following this second hemorrhage, morphine gr.  $\frac{1}{4}$  (hypo.) was given, and in twenty minutes he was asleep and rested well until morning. Excepting the fall in blood-pressure to 90 systolic, 65 diastolic, there was no apparent ill effect of the accident, so the same general treatment was continued as before. However, the improvement was very slow, and by December 19, 1915, the blood-pressure was only 80 systolic, 55 diastolic, and the hæmoglobin 75 per cent. On this date at 7 P.M., another hemorrhage started exactly as before, but was stopped by the nurse in about twenty seconds, by compressing the common carotid artery as had been done the previous week, and the loss of blood was not more than 50 c.c. After a hypo. of morphine, gr.  $\frac{1}{4}$ , sleep was secured and continued uninterrupted throughout the night. The next morning, the patient was very nervous, appetite gone, and apparent anæmia very marked.

He was immediately taken to the operating room and the left common carotid artery ligated under local anæsthesia. The operation lasted but twenty minutes. Through a cross incision 4 cm. above the clavicle, we cross-cut the sternomastoid muscle and ligated the left common carotid artery with chromic catgut. After complete closure, we freely split the original flap upward and packed the defect with iodoform gauze.

Morphine gr.  $\frac{1}{4}$ , hypo., was required morning and evening for the first three days for restlessness only. He never at any time suffered any pain. The following three days only the evening dose of morphine was needed, after which no opiates of any kind were given. Narcotics were never necessary. The blood-pressure and hæmoglobin during the ten days patient was in bed are as follows:

and seemed to be wholly free from any sign of recurrence of the malignant disease.

*A Study of the Literature.*—In 1795, Mr. Abernethy tied the common carotid for hemorrhage, but without success. Mr. Flemming was the first to successfully ligate this vessel for hemorrhage in 1803. The first ligation of it for aneurism was made by Sir Astley Cooper at Guy's Hospital, in 1805, the patient dying nineteen days later. However, in 1808, he repeated the procedure with a successful outcome. Since that time this important vessel has been tied, with varying degrees of success, many hundreds of times in the treatment of a great number of morbid conditions. One of the most interesting chapters in the whole of surgery is made up of the conclusions of the various authors who have collected these results in the past.

Pilz, of Breslau, collected 600 cases of ligation of the common carotid, in 1868. In 386 cases of single ligation, 96, or 25 per cent., showed cerebral symptoms. Over one-half of the 96 died. In 27 cases, both common carotids were tied, 5 were fatal, 2 being deaths from cerebral disturbance. There were convulsions in another, not causing death, however. There were three temporary disturbances of vision. In one case, where both carotids were tied simultaneously, coma and death resulted. When an interval of a few days or weeks is allowed, double is no more dangerous than single ligation. The most common cause of death is cerebral disease.

G. W. Morris, from records of the Pennsylvania Hospital, in 1847, collected 42 cases of ligation of the common carotid, with 13 deaths.

Fisk cites that Cripps collected 50 cases of ligation of the common carotid in American and English literature, in which 56 per cent. had brain symptoms.

Schlatter collected 789 cases of ligation of c. c. a., 49 developed hemiplegia, 1 imbecility, and 18 delirium, convulsions and other cerebral disorders. Of those who lived a short time, or recovered, more than 7 per cent. developed paralysis.

Wilder says the statistics of Reuchlin and de Schweinitz show that in 150 cases of ligation of this artery, 97, or 64.6 per cent., were cured, 38, or 25.3 per cent., were failures, 15, or 10 per cent., died. The ligation of the common carotid is a safer procedure than ligation of the internal carotid because liberal anastomosis between right and left externals allows some blood to flow back around the bifurcation of the common and hence the brain is not so suddenly exsanguinated as if the internals were tied.

Callison and MacKenty reviewed 60 cases in the literature, find-

## LIGATION OF THE COMMON CAROTID ARTERY

For six days it continued, the numbness occurring in the morning just after the night's sleep, but this also then disappeared. For five days a "creepy" feeling was noted on the whole left side of the head, which would come and go, lasting but twenty minutes at a time. This was first complained of twenty-four hours after the operation, and on the sixth post-operative day disappeared completely.

On the tenth post-operative day, patient was allowed out of bed, and two days later was discharged. The blood-pressure remained 115 systolic, 75 diastolic, after he was up. There was no difficulty in walking or doing anything else. The upper wound had completely granulated in, and the skin had begun to cover the defect. Practically all discharge had ceased and the general condition was excellent. The red blood count was 4,544,000; white blood count 6400; hæmoglobin 75 per cent. Urine and fæces examinations were negative. There was no mental defect and the patient said he had never felt better in his life.

The happy termination of this case is referable to most persistent and painstaking after-treatment. A physician and nurse were constantly on guard after the first hemorrhage, with instructions as to how to compress the carotid artery against Chassaignac's tubercle. And the patient himself, a most intelligent man, coöperated in every detail of our organized campaign to save his life.

He was seen again on October 6, 1916 (about ten and one-half months after the operation), when his condition was as follows: There were no subjective symptoms of any kind, states that he can chew well enough for practical purposes with the few imperfect teeth that remain on the right side. There is surprisingly little deformity in view of the extensive bone removal, while the remaining half of the mandible is but slightly drawn toward the defective side. The scars are white, elastic, and not overly prominent. The patient is so well pleased with his appearance, that no beard is considered necessary, although a very heavy one is well within the possibilities in his case. His weight is 193 pounds, and the blood-pressure is 118-78, hæmoglobin 85 per cent., red count 4,480,000, white count 7000, clotting time, one and three-quarter minutes; urine is pale yellow in color, specific gravity 1010, reaction acid, there is no albumin, no sugar, no acetone, no indican, microscopic examination reveals nothing of pathological importance. Heart and lungs are apparently normal.

He was seen for the last time on December 28, 1916, just thirteen months from the day he first entered the hospital, and found to be in perfect condition. He had long been at work



3. King, in a man forty, ligated the carotid and the subclavian arteries for an aneurism in the neck. No cerebral symptoms.

4. Lediard, for aneurism of the arch of the aorta, tied the carotid and subclavian arteries in a man forty-two. No cerebral symptoms.

5. Palmer reports a case that died of hæmoptysis and convulsions 125 days after ligating the carotid and subclavian arteries for aneurism of the aorta and innominate.

6. Wyeth, in a woman forty-two, simultaneously ligated the carotid and subclavian for aneurism of the aorta. No cerebral symptoms.

7. Bryant had a man, forty, die nineteen days after ligating the left carotid for innominate aneurism. Œdema and gangrene of the left lung.

8. Jaeffreson, woman forty-five, for aneurism of the carotid in the left cavernous sinus tied the common carotid. Aphasia in three days, paralyzed right side on the seventh day, and died on the eighth day.

9. Barwell reports 4 cases of ligation of the common carotid and subclavian arteries for aortic aneurism. Three of the cases successful.

10. Heath tied the common carotid in a woman, twenty-three, for aneurism of the external carotid. Good recovery to thirty-third day, then paralysis, and died thirty-fifth day.

11. Lyman tied the carotid with double silk ligatures and divided the artery in the treatment of innominate aneurism. Transient headache, hoarseness, and cold right ear. Patient died one year later of exhaustion.

12. Padeger did a simultaneous ligature of the carotid and subclavian arteries for innominate aneurism in a man, sixty. Left hemiplegia two days later. Recovered sensibility but not motion. Died year later with pneumonia.

13. Bull successfully tied the common carotid in a case of pulsating exophthalmos of traumatic origin. No cerebral symptoms.

14. Post removed portion of the common carotid in removing a tumor of the neck. Temporary paralysis of bladder. Death four months later.

15. Bettman cured pulsating exophthalmos by ligating the common carotid. No cerebral symptoms.

16. Morris, after one unsuccessful attempt, tied the common carotid for aneurism of external carotid in a woman forty-five. No effect from the ligation.

17. Lilienthal, for pulsating exophthalmos in a woman twenty-nine, tied both common carotids. Interval between operations fourteen days. Recovery.

18. Summers, in a man forty-five, ligated both external carotids, and sixteen days later the left common carotid for an angioma of the scalp. No cerebral symptoms.

19. McBurney reports a successful ligation of the carotid and subclavian arteries for innominate aneurism. Male thirty-five.

20. Wharton reports innominate aneurism cured by double distal ligation of common carotid and subclavian arteries. Operation by Ashhurst. No cerebral symptoms. Man forty-two.

21. Cameron, for innominate aneurism tied the right carotid and subclavian arteries in a woman fifty-seven. Recovery with no cerebral symptoms.

22. Stimson, male thirty-four, tied common carotid and subclavian arteries for innominate aneurism, with no cerebral symptoms. Death twenty-one months later of phthisis.

## LIGATION OF THE COMMON CAROTID ARTERY

ing 3 carotids ligated in 32 cases, at 54 operations. Of the 22 deaths, 3 were from hemorrhage, 2 of cerebral anæmia, 1 of acute œdema of the lungs, 1 of septicæmia, and 1 of infection and hemorrhage. In the surviving cases, 4 had aphasia and hemiplegia, 4 had voice affected and dysphagia, 5 had tongue deviated to side, 4 had an altered pupil, and 4 had face partly paralyzed.

Martin gives *general* mortality of ligating common carotid 20 per cent. plus, and mortality of ligating it in pulsating exophthalmos as less than 2 per cent. De Schweinitz and Halloway give mortality of ligating the common for this malady as 1 per cent., with 10 per cent. disturbance of the cerebral nervous system. The carotid ligation is successful in two-thirds of the reported cases.

Wyeth cites 67 cases from literature of ligation for aneurism in which there were 14 cures, 1 improvement, 2 recoveries with permanent cerebral complications, 7 deaths from cerebral complications, 43 deaths from rupture of sac, hemorrhage, asphyxia, or some intercurrent disease.

It will be seen from the foregoing statistical studies that about one-third of all the patients on whom ligation of the common carotid has been performed died. When one takes into consideration that very many of these operations were done in the pre-aseptic period, it may be assumed that the mortality for the age in which we work will be considerably lower. The practical deduction to be drawn, however, is that an operation attended by a mortality of about 33 per cent. is distinctly preferable to the repeated recurrence of secondary hemorrhage in a region where it leads, as is generally agreed, to a 100 per cent. mortality.

In order to determine just what per cent. of ligations have been done for the control of secondary hemorrhage resulting from surgical procedure, like the one reported above, we have carefully studied the first 105 cases, including our own, which confronted us in the literature. Eighty-two of these ligations were done for aneurism, pulsating exophthalmos, angioma of the face and scalp, as preliminary to, or simultaneously with, the removal of tumors in the carotid area, and for trifacial neuralgia.

### LIGATION OF COMMON CAROTID FOR INDICATIONS OTHER THAN HEMORRHAGE

1. Browne reports a successful case of simultaneous ligature of the subclavian and carotid arteries for innominate aneurism. Male, thirty-two. No cerebral symptoms, and result good.

2. Wolfe had a case of aneurism in the orbit which he cured by ligature of the common carotid. Woman twenty-two.

in a woman forty-eight years with an innominate aneurism. Complete recovery. This was his sixth case, with five recoveries.

42. Banks had a case die of hemorrhage after ligating the carotid and subclavian arteries.

43. Stimson, in a man forty-eight, first tied the common carotid for an aneurism of the innominate, and noticed no cerebral symptoms and no improvement. A year later he ligated the subclavian and noticed some improvement. Patient died three years later of Bright's disease and pulmonary cedema.

44. Wyeth had a man, fifty-four, die twenty-six hours after incomplete removal of a neck tumor, which had involved the common carotid to such an extent that it and other vessels had to be tied.

45. Wheelock reports a case of traumatic exophthalmos, female eleven years. Ligation of right common carotid gave only temporary improvement. Complete recovery followed ligation of left common carotid, one year later. No cerebral symptoms.

46. Damainville, female, forty-three years. The case was one of pulsating nœvus on the right cheek. Recovery after ligation of right common carotid. Transient pain in right arm.

47. Bull, in a man, twenty-six years, ligated the common carotid for aneurism of external carotid. Left pupil contracted, tongue deviated to right, slight loss of power in right hand, face drawn to right side, speech O. K. Symptoms cleared in a few days.

48. McGill ligated the common carotid for right carotid aneurism. The patient, a woman sixty-two years old, suffered no cerebral symptoms and completely recovered.

49. Wells observed no symptoms after ligating the common carotid and right subclavian arteries for aneurism of the aortic arch in a female of seventy years.

50. Keen and Funke had a patient die of cedema of the lungs two days after ligation of the common carotid for a tumor of the carotid gland.

51. Marchand, in a woman thirty-two, ligated three carotids and a jugular vein for lymphoma of the neck. Patient died the third day of bronchopneumonia.

52. Paltauf observed hemiplegia, paralysis of right hypoglossal and facial nerves, and aphasia, on the fourth day after ligation of three carotids in removing a lymphoma. Symptoms cleared, aphasia last of all; no recurrence in four years.

53. Paltauf also experienced a death in a few hours from secondary hemorrhage following the ligation of three carotids and a jugular.

54. Paltauf ligated three carotids in removing tuberculous glands in a woman eighteen. Post-operative paresis of the left vocal cord.

55. Kauffmann and Ruppenner ligated the common carotid, internal carotid, and jugular, in a woman of twenty. There was hoarseness, and a small inactive left pupil. Patient died on the second day of double inhalation pneumonia.

56. Kopfsstein noticed a narrowing of the left pupil, paralysis of the left palate, and hoarseness of voice, after ligating three carotids, superior thyroid, lingual, external maxillary, ascending pharyngeal and jugulars.

57. Malinowsky reports a recovery, after ligating three carotids, superior thyroid, external maxillary, and jugular, in a woman of thirty.

58. Monckeberg ligated three carotids, and noticed a right sided facial paralysis and aphasia on the second day. Patient recovered.

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23. Dent reports the death of a man, thirty-seven, after simultaneous ligation of the carotid and subclavian arteries ten days before, for innominate aneurism.

24. Godfray had a case of aneurism of the carotid with suppuration of the sac and rupture into the pharynx. Ligation of the common carotid. Male twenty-six. No cerebral symptoms; recovery.

25. Collins successfully ligated the common carotid in the treatment of an intracranial aneurism. No cerebral symptoms.

26. Collins also ligated the common carotid artery in a case of recurrent carcinoma of the tongue, tonsil, and floor of mouth. The patient, a woman of thirty-seven, improved generally in health.

27. Kennedy cured a pulsating exophthalmos in a man of fifty, by ligating the common carotid.

28. Parker tells of a sudden death one year after tying the common carotid in a man of forty-eight, during the removal of a tumor from the stylohyoid region. No immediate symptoms.

29. King ligated the external and common carotids for an intracranial aneurism in a woman thirty-two. Right hemiplegia and paralysis of left side of face and aphasia. Recovery with partial hemianæsthesia.

30. McIntyre ligated the external and common carotid arteries, in removing a lymphoma of neck. Pain at base of brain and dizziness for two days. Secondary hemorrhage controlled by compression.

31. Stimson reports a case of arteriovenous aneurism six months after a stab wound in the neck. Male twenty-five. Common carotid ligated. Loss of power of right hand and dizziness on fourteenth day. Recovery.

32. Marsh, in a man thirty years with aneurism of the aorta, tied the carotid and subclavian arteries. Man died of rupture of the sac three hours later.

33. Ballin cured a case of pulsating exophthalmos in a man forty-two, by ligating the common carotid. No cerebral symptoms.

34. Ricketts successfully ligated the common carotid for trifacial neuralgia. Gives list of 18 cases from the literature; 2 had temporary paresis.

35. Nicoll removed the tongue, right tonsil and fauces for cancer, seven days after ligation of the right common carotid and left lingual arteries.

36. Hechelman reports an uncomplicated recovery after ligating the common carotid in a case of pulsating exophthalmia. Female twenty-four years.

37. Ransohoff in a male twenty-two, ligated the common carotid for pulsating exophthalmos with good results. Collected 21 cases in which the common carotid was tied with 14 cures.

38. Harrington removed a malignant growth from the neck which had involved a considerable portion of the common carotid. No cerebral symptoms. Hoarseness and inability to swallow were transient symptoms. Made good recovery, but died four months later from the progress of the cancer.

39. Croft had a case of glandular swelling of the neck which corroded into a pulsating tumor-like aneurism. Common and external carotids tied. Complete recovery.

40. Sheldon ligated the common carotid for aneurism of the innominate artery in a male forty-two years. Patient had a severe secondary hemorrhage and died before the innominate could be tied.

41. Barwell did a simultaneous ligation of the carotid and subclavian arteries

76. Cathcart, in a man thirty-three, tied the common, internal, and external carotids in removing a tumor of the neck. No symptoms.

77. Zondek tells of a good recovery made by a patient sixty-three years old, after a ligation of three carotids in the removal of the carotid gland.

78. Graham reports an operation by Crile, in which he ligated all of the carotids; recurrent laryngeal, and superior cervical sympathetic nerves were divided. Severe shock. Next day left pupil contracted, left eye parietic, marked hoarseness. Weakness of calf muscles and arm developed. Otherwise complete recovery.

79. Boni mentions no post-operative sequelæ following ligation of the common, external and internal carotids in removing a tumor of the neck.

80. Martin tells of a cure of pulsating exophthalmos following ligation of the common carotid artery, in a man forty.

81. Martin, in a man fifty-six, cured deafness of the right ear, blindness, tinnitus, and pulsating exophthalmos, by tying the right common carotid until the orbital pulsation ceased. Recovery.

82. Martin again successfully treated a pulsating exophthalmos by partial occlusion of the common carotid artery in a man twenty-four.

Seven of these 105 ligations, which were analyzed, were made in the treatment of spontaneous hemorrhage into the nose, nasal pharynx, oral pharynx or mouth.

1. Thomas records a case in which he ligated both common carotid arteries to control severe epistaxis in a case of inoperable sarcoma of the jaw. The first ligation gave only temporary relief, and was followed by no symptoms. The second ligation; done two months later, was followed by death in coma on the next day.

2. Wyeth, in 1881, tied the right common carotid of a woman fifty-three. Hemorrhage from a malignant growth of the antrum and orbit successfully stopped. Patient died seven months after ligation.

3. Collins ligated the right common carotid in a man of fifty-three, for hemorrhagic ulceration of right tonsillar region. Condition greatly improved.

4. Mahomed, in 1882, stopped a hemorrhage from a post-pharyngeal abscess, by ligating the common carotid. Recovery with fixation of the left vocal cord.

5. Wilkinson controlled bleeding from an angioma of the face, by ligation of the common carotid, after an unsuccessful attempt by ligating the facial artery. No cerebral symptoms.

6. Ferguson in the case of a woman, nineteen, suffering with aneurism by anastomosis on the head, and severe hemorrhage, ligated the common carotid. No cerebral symptoms. Recovery.

7. Blaker ligated the common carotid artery of a man, forty-five, with a case of epithelioma of tongue, with repeated hemorrhage from lingual artery for two days. Transient pain was present in left arm, right knee, and side of face, head, and tongue. Death in five months.

Only 15 of the 105 ligations which we are studying in detail were made for the control of hemorrhage, secondary to surgical operations,

## LIGATION OF THE COMMON CAROTID ARTERY

59. Monckeberg, in a man fifty-two years, ligated the common and internal carotids and internal jugular vein. Patient died on the third day with hemiplegia, aphasia, and inhalation pneumonia.

60. Siniouschine ligated three carotids in a woman forty-one; tongue deviated to the left, and drooping of right angle of mouth; recovery.

61. Scudder ligated three carotids in a woman thirty-two years. Recovery.

62. MacPhatter reports a complete recovery in a woman thirty-one, after ligating three carotids and the jugular.

63. Funke ligated three carotids and the internal jugular in a man forty-eight years. On the eighth day had severe headache, rapid loss of weight, irrational, and died in nine weeks of cerebral hemorrhage.

64. Gilford and Davis in a man sixty-two, ligated three carotids. Hemiplegia and pneumonia, with death on the seventh day.

65. Da Costa tied three carotids of the internal jugular, of a man fifty-two. Twelve hours after operating, patient had left hemiplegia, which rapidly cleared in a few days. Secondary hemiplegia occurred a week later, and slowly cleared; atelectasis of one-half the left lung. Recovery.

66. Howe ligated the left common carotid artery in the removal of the lower jaw of a female of forty-nine years. Hemiplegia of right side next day. Coma following day, death the fourth day.

67. Grene tied three carotids in a female, seven years, for a tumor of the right side, followed by right sided paralysis; never entirely recovered.

68. Makara reports a death of softening of the brain, on the third day after ligating the common, internal, and external carotids in a man eighteen, who had a tumor of the right side of the neck. Hemiplegia, and fever and dysphagia on the second day.

69. Dobremischoff: female, twenty-five, death the next day after ligating the three carotids for tumor of the left side.

70. Wooley and Fee had a case of goitre and tumor on the right side in a woman of sixty-eight. Patient died on the twenty-third day, of septicæmia.

71. Lilienthal noticed complete aphasia and hemiplegia, left eyeball soft and contracted, on the day following a ligation of the common carotid, in a woman fifty-six, whose primary lesion was an endothelioma of the carotid body. Aphasia and hemiplegia disappeared, but pupil remained contracted.

72. Cook excised the common carotid, which was involved in a tumor, in a man thirty-nine. Patient died one hour later of shock.

73. Eliot cured a pulsating exophthalmos by ligating the common carotid artery. No cerebral symptoms. Recovery.

74. Wilder reports pain in head for one week and occasional neuralgic pains in right side of face and head, after ligating the external carotid for pulsating exophthalmos.

75. Wilder reports another case of pulsating exophthalmos, which was finally cured by ligating the common carotid. Three days later, patient had complete paralysis of the muscles of left forearm and hand and difficult speech. Speech returned, but muscular power not completely. He makes a note that ligation of the common carotid is a safer procedure than ligation of the internal, because the liberal anastomosis between the right, and left external carotids allows some blood to flow back around the bifurcation of the common carotid, and hence the brain is not so suddenly exsanguinated as if the internal were tied.

A perusal of the 105 cases quoted above will show that only 15.25 per cent. of the ligations were done for secondary hemorrhage, while 6.66 per cent. were done for spontaneous bleeding in the carotid areas. 78.1 per cent. were undertaken in the treatment of conditions which did not immediately indicate a speedy approach of death. Surprising as is the outcome of this analysis, it coincides fairly well with our clinical observations; for we know of a rather large number of patients (some of them our own) who have succumbed to recurring spontaneous or secondary hemorrhage without any attempt being made to relieve the condition by ligation of the common carotid. This statement becomes all the more impressive in view of the fact that 10 of the 15 patients studied above made a complete recovery after ligation of this artery in the treatment of repeated secondary hemorrhage from its branches. It will be seen that the mortality attending this treatment of secondary hemorrhage, with its otherwise practical certainty of a speedy fatality, is no greater than the general mortality of about 33 per cent. which has followed the ligation of this large vessel in many hundreds of instances in the treatment of the greatest varieties of pathological conditions. We are forced to the final conclusion that secondary and spontaneous hemorrhages from the branches of the common carotid are very frequent, and still ligation of this vessel, which saved two-thirds of the patients involved, was performed for this indication in but 15.25 per cent. of the cases analyzed. Must we not then ask ourselves in all seriousness, why modern surgery has *not* furnished this 66 per cent. chance to those sufferers who practically all die, under circumstances of a particularly distressing nature, unless this simple operation be performed?

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etc., involving injury to one of the branches of the common carotid artery.

1. Rivington, male thirty-one, stab wound in neck which became infected and gave rise to severe hemorrhage on twenty-first day. Common carotid ligated, then external carotid ligated and ligature loosened from common carotid; recovery.

2. Sands encountered an obstinate hemorrhage after an amygdalotomy in a man of twenty-four years. Patient prostrated, saline infusion; recovery.

3. Byrd had a case, boy seven, of gangrene of cheek and neck, starting from a carious tooth. External carotid eroded, hemorrhage, common carotid ligated with no cerebral symptoms. Death in two days from general sepsis.

4. Ashhurst reports epileptiform convulsions coming on six months after ligation of the common carotid for secondary hemorrhage from a stab wound in the neck.

5. O'Neill, male forty, for hemorrhage from incised wound behind angle of jaw, ligated the common carotid; delirium for two days and severe pain in side of face. Slight facial paresis for four months, but final recovery.

6. Browne cites an instance of a man thirty-two years, who had severe hemorrhage from infected neck laceration following a kick from a horse. Involuntary bowel movements for three days following common carotid ligation; recovery.

7. Preston, male, forty-seven, an attempted suicide by cutting throat. Wound infected and severe hemorrhage six days later. Common carotid tied. Improvement for a month. Death three months later from apoplexy. Postmortem showed softening of base, and cerebellar abscess.

8. Jones, S. E., excised the left half of inferior maxillary, in a man fifty-five years old, with epithelioma of lip and infection of two years' duration. Hemorrhage from left side of the mouth followed. He ligated the common carotid artery. Patient given saline transfusion. Complained of headache in left side, but no other cerebral symptoms.

9. Rivington, in a boy nine years, who had severe hemorrhage after swallowing a fish bone, tied the left common carotid artery. Death ten days later, of brain abscess on left side.

10. Thorner performed ligation of the common carotid artery successfully on a man, thereby controlling epistaxis in the most serious form.

11. Shepherd reports ligation of left common carotid for meningeal hemorrhage. Aphasia for two days. Recovery.

12. Hewetson resorted to ligation of the left common carotid artery, and saline infusion, to control hemorrhage for an eroding cancer of the neck. Right-sided hemiplegia and dilatation of the right pupil and contraction of the left pupil were noticed on the day following ligation. Patient died without regaining consciousness.

13. Callison and MacKenty tell of a fatal termination of an attempt to ligate the common carotid to stop severe hemorrhage, incident to the removal of a malignant mass.

14. Lane saved the life of a man, twenty-one, with severe hemorrhage after tonsillectomy, by ligating the common carotid and infusing saline solution.

15. Ransohoff ligated the common carotid for secondary intracranial hemorrhage. Conscious the next day. Result not reported.



# A STUDY OF THE MOTOR DISTURBANCES ACCOMPANYING ULCER OF THE STOMACH OR DUODENUM AND THE CHANGES PRODUCED BY OPERATION

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IN discussing the disturbances of function which are initiated by ulcer of the stomach or duodenum, the factor produced by any derangement of activity of the gastric musculature becomes an all-important one. After operative treatment for the cure of the ulcerative lesions, these motor disturbances do not always disappear immediately, but frequently continue for a variable length of time after convalescence is established and may cause the production of post-operative symptoms. These symptoms may have nothing to do with the original lesion, with a recurrence of it or with the appearance of new lesions of similar character but are incident to the proper recovery of the motor mechanism to normal conditions.

The special purpose of this report is to demonstrate the disturbances of motor function which accompany these ulcerative lesions and to point out the relationship of the particular disturbance to the actual lesion. The changes occurring after operation will next be considered and the differences or similarities to the ante-operative findings noted. Finally the post-operative changes will be followed over considerable lengths of time, and, when disturbances of function persist or reappear, the coincidence of these with post-operative symptoms of one kind or another will be described.

The methods made use of are those which were employed by Cannon and Washburn<sup>1</sup> and by Carlson<sup>2</sup> in purely physiological work, and for our purpose they were peculiarly applicable inasmuch as the studies reported here had to do with changes in the normal physiological functions of the gastric musculature which were caused by disease or which follow the formation of new anatomical relationships produced during operation.

*Historical.*—Observations of this kind were made as early as 1897 by Duchessi<sup>3</sup> who noted that the muscular activity was depressed in diseased conditions. Sick<sup>4</sup> in 1906 made observations in cases of large

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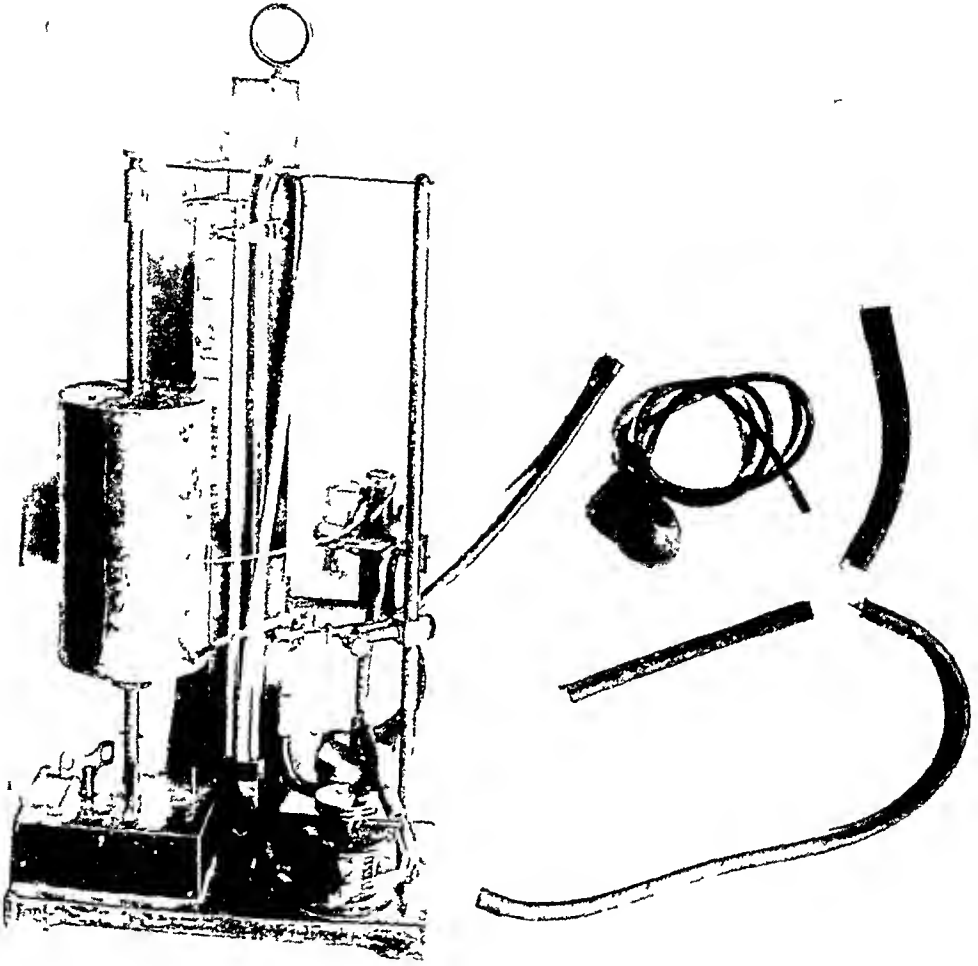


FIG. 1.

inations made by Dr. Jaches \* and his associates in the X-ray Laboratory of Mount Sinai Hospital.

*Physiological Work.*—The work † of Cannon and Washburn<sup>1</sup> and of Carlson<sup>2</sup> has shown that in normal stomachs there is a constant variation in the tonicity of the smooth muscle layers, which, graphically, is represented in the kymographic tracings as a rhythmical rise and fall of the lever repeated about once every twenty seconds. The intragastric pressure is only of moderate degree (up to 5 mm. Hg). These slow contractions are interrupted at regular intervals by sharp rises of the lever to greater heights which correspond to pressures many times as great as in the preceding variations. These indicate active contractions of the stomach wall. The latter are known as "hunger contractions," the former as "tonus contractions."

The hunger contractions may repeat themselves rapidly for periods lasting up to an hour or more in length, or are separated by periods of varying length in which only tonus contractions appear.

*Pathological Work.*—The cases upon which the studies reported in this paper were made were all pathological, and in all of them, with the exception of the control cases, a "peptic" ulcer could be demonstrated at operation, either in the stomach or duodenum. The observations ‡ to date number ninety-three. Of these eighteen are controls, the records having been obtained from patients in whom, later at exploratory operation, no lesion could be found in the stomach or duodenum. In a number of the cases the records are not complete inasmuch as there is lacking either an ante-operative or a post-operative observation.

The state of the motor activity before operation has been found to conform to one of five types and these types may be classified as follows:

(1) The normal type: The tracings obtained in this group are similar in all points to those obtained as a rule from stomachs which show no lesion at operation, or in which there are no subjective symp-

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\* I am indebted to Dr. L. Jaches for permission to make use of the records of the X-ray Laboratory.

† It is unnecessary to repeat here in detail the original work done by Cannon and Washburn and by Carlson and his associates. For more detailed information reference is made to the original articles in the *American Journal of Physiology* for 1911 to 1915.

‡ The majority of the patients were observed while on the surgical service of Dr. A. A. Berg, to whom I am indebted for the permission of making these studies. The other cases were studied while on the surgical services of Drs. Moschowitz, Elsberg, and Beer, or while on the medical services of Drs. Meyer, Brill, Manges and Libman. I am indebted to all of these gentlemen for the permission of making these observations.

## MOTOR DISTURBANCES FROM GASTRIC ULCER

dilated stomachs in which he could see few tonus contractions and no hunger contractions. He also studied cases of pyloric stenosis and in these he recognized the erections of the stomach in the exaggerated tonus and hunger contractions of the tracings.

Kirschner and Mangold<sup>5</sup> studied the function of the gastric antrum and the pyloric sphincter after resection in continuity of the middle segment of the stomach. The rhythm and gastric contractions were unchanged.

In 1915 Carlson and Ginsburg<sup>6</sup> studied two infants with congenital pyloric stenosis. They demonstrated hypertonicity and hypermotility.

In 1916 Luckhardt and Hamburger<sup>7</sup> obtained records from a patient with gastric carcinoma and in a condition of acute gastritis. Little disturbance was noted in the former and a complete absence of motor activity in the latter.

*Method.*—By the methods of Cannon and Carlson kymographic tracings are obtained which record the intragastric pressures and the changes in rhythm and force of the tonus and hunger contractions as described in the original physiological work of Cannon and Washburn<sup>1</sup> and of Carlson<sup>2</sup> and in some of our work<sup>8, 13</sup> previously published. These tracings are obtained by introducing into the patient's stomach a small-sized rubber (toy) balloon which is connected by means of a narrow calibered rubber tube with a tambour and recording needle and with a mercury manometer. Transmission of the intragastric variations occurs through the column of air in the balloon and tubing. The apparatus which was used was extemporized out of an old discarded Erlanger sphygmomanometer and a photograph of our apparatus is shown in Fig. 1.

Extraneous inhibiting influences which would tend to negative the reliability of the records obtained were rigidly excluded in the cases reported upon in this paper and no tracing was accepted when tolerance of the tube and balloon was not exhibited. As a general rule, owing to previous manifold experiences with stomach examinations of one kind or another, the patients were enabled to swallow the balloon and tube voluntarily and with ease and frequently within a short time dropped off to sleep and continued in that state for the major part of the observation. The length of time for which records were made varied between one-half and one hour. Whenever the tracing method showed no evidence of muscular activity, the record was controlled by having the examination repeated on a subsequent day. When all of these factors were considered the records furnished true indices of the state of the motor activity and the changes in intragastric pressure. These records were then compared with the results of X-ray exam-

The cases gathered in the first three groups are simple uncomplicated ulcer cases and in none of them had anatomical abnormalities resulted from the ulceration such as stenosis of the pylorus or cicatricial distortion of the body of the stomach.

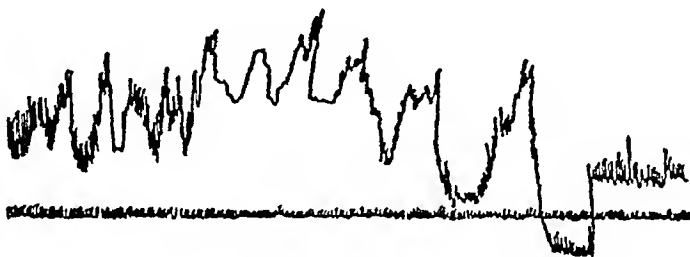


FIG. 4.

In the two groups which follow, anatomical changes appear.

(4) The type seen in pyloric obstruction: When the stenosis is only of moderate degree and has not existed for an excessively long time the changes are slight and consist of a slowing of the rhythm with an increase in the intragastric pressure (Fig. 5). In the more advanced cases the tonus exhibits this same change to such a degree that at intervals the tonus contractions assume the characteristics of hunger contractions. This represents the peristalsis that is at times visible

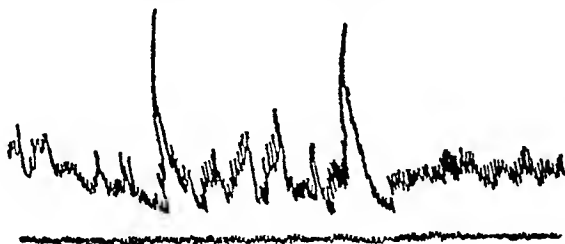


FIG. 5.

through the abdominal walls of these patients. In badly neglected cases all motor activity may be lost owing to the development of a secondary atony and the curve then indicates a large atonic and dilated organ (Fig. 6). This group comprises about two-fifths of the cases.

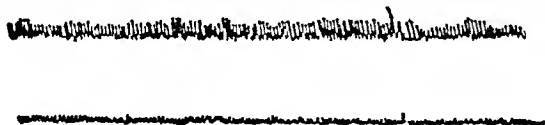


FIG. 6.

(5) The "atony" group: This division includes some of the cases in the preceding group in which the stenosis has initiated an exhaustion of the musculature and a terminal paralytic condition. It

## MOTOR DISTURBANCES FROM GASTRIC ULCER

toms of any kind that would lead one to suspect any abnormality of the stomach (Fig. 2). In these cases the lesion is usually found in the duodenum or at some part of the stomach in which it gives rise to little or no motor disturbances. About one-fifth of the records are of this type.



FIG. 2.—In this and all the other figures the upper curve represents the contractions of the stomach musculature and the lower curve is a control for the respiratory factor obtained from a pneumograph fastened about the lower thorax and upper abdomen.

(2) The hyperactive type: Large hunger contractions begin immediately and continue practically unchanged during the entire period of observation (Fig. 3). The tonus is distinguishable with difficulty and is overshadowed by the hunger contractions. The lesions are usually in the duodenum. These cases are in the minority.

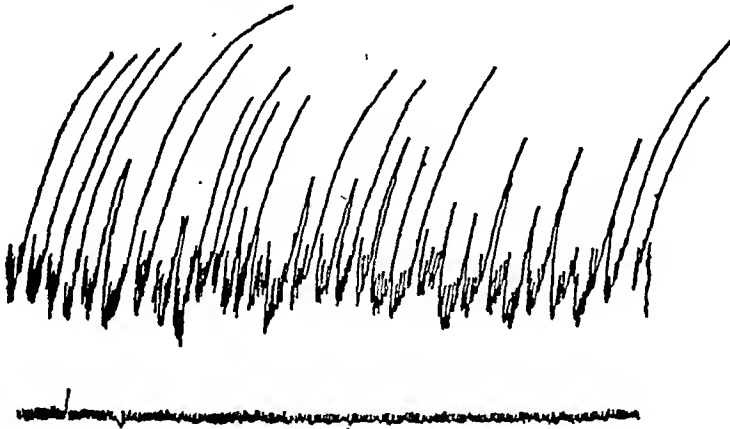


FIG. 3.

(3) The irregular type: The tonus has an irregular rhythm both in time and force and sometimes is replaced by atonic periods. The hunger contractions are also irregular in time and force and frequently lack the bold rise and fall of the healthy contractions (Fig. 4). The lesions are usually found in the antral portion of the stomach and along the lesser curvature. This type is present in about one-fifth of the observations.



by suture or Murphy button, or in (b) a pylorotomy or partial gastrectomy with the necessary gastrojejunostomy usually made with a Murphy button. The sequence of events in the gastro-enterostomy cases (group a) which followed the operation may be summarized as follows:

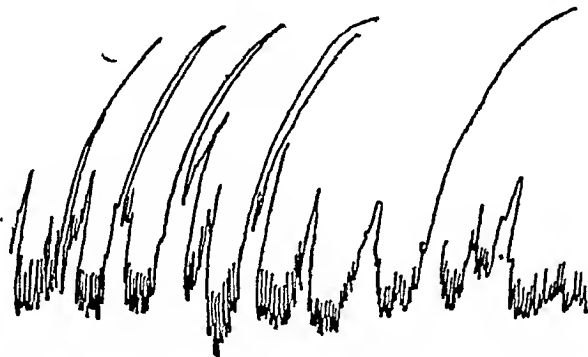


FIG. 8.—Same case as Fig. 7. Tracing obtained two weeks after operation.

1. The recovery to the normal was fairly rapid, and even as soon as two weeks after the operation very good tonus and hunger contractions could be demonstrated. These cases are in the minority.

2. The recovery to the normal was slower than in the first group, but for practical purposes was satisfactory. These were the cases which were in poor condition before operation, or in which a naturally poor vitality retarded the rapidity of the convalescence.

These two groups, and especially the first group, are most often to be seen with the early or moderately early cases of pyloric stenosis. Here the muscular function is excellent and when the obstruction is remedied a rapid improvement is almost always seen. This corresponds with clinical facts, inasmuch as cases of pyloric obstruction are known usually to give good results after operation.

3. Cases in which the disturbance had been so marked that the atony persisted to a slight or moderate degree after operation, recovery was very slow.

4. Cases in which the atony persists and in which at repeated examinations none or only slight traces of motor activity are visible in the tracings.

When the original atonic condition was due to reflex causes, the condition tended to a rapid improvement after the removal of the offending cause. When, however, it was the terminal stage of a pyloric obstruction, the condition usually dragged on for long periods after operation and was difficult to treat successfully.

5. Cases in which the motor function began to regain its normal

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includes, also, those cases of large callous ulcer situated on the lesser curvature or posterior surface of the stomach in which a reflex paralytic condition has resulted from the presence of a large inflammatory lesion. Frequently the clinical findings are those of a pyloric stenosis and the condition is often associated with a high grade of pylorospasm. In these cases the curve (Fig. 6) either shows no motor activity at all or only traces of tonus contractions appear separated by long intervals of total atony. No hunger contractions are seen. Such records formed about one-tenth of those obtained.

*Post-operative Observations.*—In a number of the control cases observations were made within a short time after the exploratory laparotomy. At this operation the stomach with its neighboring omenta and the transverse colon were withdrawn from the abdomen and the parts were handled in the fashion necessary for determining whether or not an ulcer was present in the stomach or duodenum. A lesion not having been found, the organs were returned into the abdomen and the external wound was closed. Such an exploration would last about fifteen minutes. In a number of these cases an appendicectomy was done.

In these cases the observations of the motility of the stomach made after recovery from the operation rendered records identical with

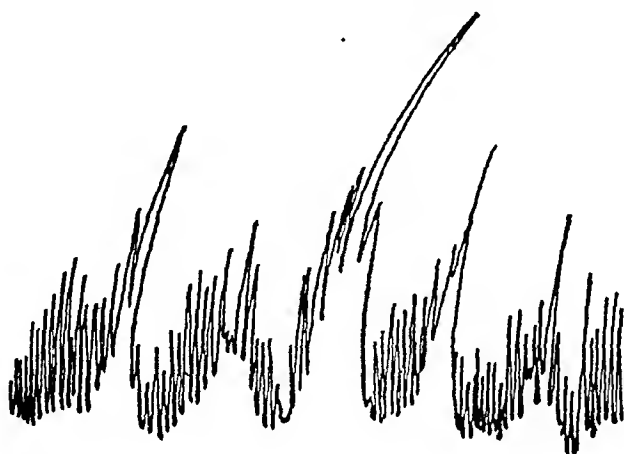


FIG. 7.—Tracing obtained before operation. Negative findings.

those before operation (Figs. 7 and 8). The handling of the organs, when no operative procedure was carried out, seemed to have no effect on the muscular function, or, if there was such an effect, it was transient and recovery to the normal was absolute and very rapid.

In the cases in which ulcers were found the operative treatment consisted either in (a) a retrocolic posterior gastro-enterostomy made

demonstrated that improvement had continued to a degree corresponding with the clinical facts.



FIG. 11.

This was a cured case and demonstrated the slow recovery of the motor function to the normal (group 2 of the post-operative classification). The reason for the retardation was the impoverished general condition in a patient not naturally robust.

CASE II.—Hospital No. 160857. This was a patient in whom



FIG. 12.

also at operation an ulcer was found in the first part of the duodenum. Similar treatment was accorded him as in the previous case described. The motor activity of the stomach before operation is shown in Fig. 13. According to our preoperative classification this would fall into group 2.



FIG. 13.

There was some vomiting during the first few days after operation after which the convalescence was uninterrupted. Twenty-six days after operation an observation was made and this is reproduced in Fig. 14. This showed a beginning return

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tone and continued to improve for a short while. Then for various reasons a deterioration occurred and later observations showed little or no evidence of motor activity.

The following two cases are cited as examples and illustrate graphically the post-operative sequence of events.

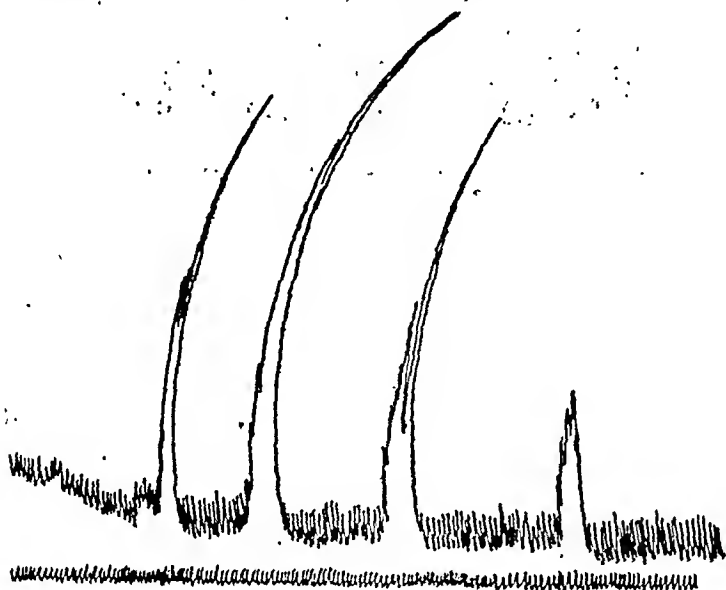


FIG. 9.

CASE I.—Hospital No. 160182. This was a patient in whom at operation a small ulcer was palpated in the first part of the duodenum, and for this a posterior retrocolic gastrojejunostomy was made after the method of Von Hacker and the pylorus was excluded by the string method. The motor activity of the stomach before operation is shown in Fig. 9. According to our pre-operative classification this would fall into Group 1. A satisfactory convalescence was made and about three weeks later another observation (Fig. 10) was made. Only slight evidences of motor

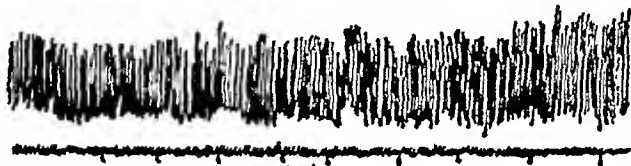


FIG. 10.

activity were present at this time. Clinically the patient was without symptoms but said that he felt weak. The observation was again repeated several weeks later and at this time the patient was feeling much stronger. The tracing (Fig. 11) demonstrated that tonus contractions were present and at one point a fairly typical hunger contraction is seen. Another observation was made two months later, by which time the patient had regained most of his strength and was feeling very well. This tracing (Fig. 12)

a longer or shorter time symptoms developed which at secondary exploratory operations were proven to be due to anatomical lesions which had produced a partial obliteration of the gastro-enterostomy stoma. In the presence of a pyloric exclusion abnormal conditions were neces-



FIG. 17.

sarily produced which resembled those noted under pyloric stenosis (ante-operative group 4) and the kymographic records showed similarities to those described under that heading.

*Comparison with the X-ray.*—In comparing the kymographic records with facts obtainable by X-ray examination, it must be remembered that with the latter method one is dealing with the stomach filled with food material (barium-zoolak mixture), whereas in the former all of the examinations were made on stomachs into which food had not been introduced for many hours previous to the examination (five to eighteen hours). A certain degree of discrepancy has been noted which can rightly be referred to this difference between the full and the empty stomach.

As a general rule the observations yielded by both of these methods of examinations have shown similarities. Wherever the motor activity gave good tonus and hunger contractions in the kymographic records, the X-ray demonstrated a "grasping" of the contained barium-zoolak mixture and the peristalsis visible was active and efficient and resulted in the emptying of the stomach within a normal period. The discrepancies mentioned above consisted mostly in seeing large peristaltic waves under the fluoroscope when no hunger contractions were seen in the tracings. It seems therefore that the digestive contractions are different from the hunger contractions. This seems to bear out the physiological observations made by Carlson<sup>11</sup> that the hunger contractions disappear immediately upon the introduction of food into the stomach. It also confirms the work done on dogs by Boldireff.<sup>12</sup>

The information rendered by the X-ray examination has often been amplified considerably by that given by the kymograph, especially in conditions of pyloric obstruction and stenosis of the gastrojejunal stoma. In these the obtaining of good tonus and hunger contractions would indicate that the musculature was functioning well and that disturbances of motor function after operation would be little or none. On the other hand, when no evidence of any motor activity was obtainable it bespoke an exhausted musculature and indicated a long period

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of the tonus contractions. No hunger contractions were demonstrable. There were no symptoms at this time. Six weeks later the patient returned complaining of pain and vomiting. An observation made at this time showed no motor activity (Fig. 15)



FIG. 14.

The symptoms continued unchanged and the observation was repeated three weeks later. The atonic condition still persisted (Fig. 16).

Six months later the patient was readmitted to the hospital and the observation made at that time demonstrated fairly satisfactory tonus contractions but no hunger contractions (Fig. 17).



FIG. 15.

A secondary exploratory operation was made but no anatomical lesion could be discovered. It was concluded, therefore, that the disturbances of this patient were of a functional nature.

This case falls into group 5 of our post-operative classification. Operation was followed by a temporary improvement, after which a deterioration occurred in the function of the gastric musculature. This corresponded with an appearance of post-operative symptoms. A discussion of this case was made in another publication.<sup>10</sup>

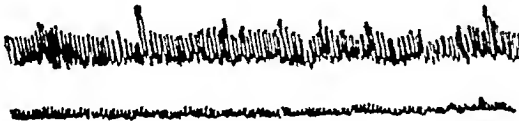


FIG. 16.

There were only a few observations on cases in which the method of operation consisted of a pylorotomy or partial gastrectomy (group b). In a general way it may be stated that the recovery to the normal after this type of operation followed the same general rules as after gastro-enterostomy. Disturbances of function were, however, relatively fewer and were less marked.

There were a few studies on gastro-enterostomy cases in which after

# AN ANATOMICAL POINT WHICH FACILITATES THE LOCATION AND DELIVERY OF THE APPENDIX

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THE attachment of the lower root of the mesentery opposite the sacro-iliac joint marks the point of juncture between the ileum and the cæcum. By its location, the appendix can be readily found and delivered without drawing any of the colon or the small intestine out of the wound. The advantages are obvious. With so little trauma to the intestine, the post-operative convalescence is made comfortable, the danger of infection is lessened, and the time of operation shortened within reasonable limits. The method can only be employed in cases in which the appendix lies free in the abdomen.

Through a muscle splitting or McBurney's incision the index and middle fingers of the left hand are inserted into the iliac fossa. The cæcum, lying directly underneath, is lifted well up in the iliac fossa by a cat's pawing action of the fingers, until the head is located (Fig. 1). The fingers are then swept along the course of the iliac vessels from without inward and upward, describing an arc of one-fourth of a circle, until the point of attachment of the root of the mesentery is reached. This is felt as a band, which marks the location of the ileocæcal juncture. The base of the appendix, if lying free in the abdomen, should be within three-fourths of an inch from this point. If the hand is now elevated slightly, anteriorly, and the fingers moved about, the appendix as a rule can be found (Fig. 2). Grasped between the fingers it can be delivered through the wound (Fig. 3).

Should a right rectus or midline incision be used, the band is located by sweeping the fingers in the opposite direction, *i.e.*, from within, outward and upward.

I have been impressed in my visits to clinics with the fact that many surgeons draw out large amounts of the descending colon and sometimes the small intestine in searching for the appendix, and that few employ the method described herein.

I am indebted to Chas. H. Mayo for demonstrating this method to me.

## MOTOR DISTURBANCES FROM GASTRIC ULCER

of convalescence in which symptoms might arise due to this atonic condition.

Occasionally in large dilated stomachs one could see fair tonus contractions in the kymographic record. Here subsequent events showed that recovery took place much more rapidly than in those cases in which no tonal waves could be seen.

In the post-operative cases the facts obtainable by the kymographic examinations are very valuable in forming part of all the information elicited according to the methods described elsewhere,<sup>8, 13</sup> which have been developed for estimating the functional capacity of the stomach. Here it helps in determining whether any post-operative symptoms which may arise are functional or due to anatomical causes. In the functional cases they are of further value in estimating the good or bad effect of the method of treatment employed.

This method of examination, while having great value in estimations of the functional capacity of the stomach both before and after operation, has, up to the present, showed very little if any value as a method of precision in the diagnosis of gastric or duodenal ulcer.

I acknowledge with many thanks the kind assistance of Dr. J. Branower; of our house staff, in the preparation of much of the technical work embodied in this study.

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FIG. 2.—*a*, showing hand swept upward toward midline; *b*, root of mesentery located and appendix grasped between fingers.

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FIG. 1.—*a*, showing position of hand through abdominal incision; *b*, pulling head of cæcum up preparatory to the search for root of mesentery.





Dorothy Peters '15

FIG. 3.—Appendix brought through incision without delivery of cæcum or ileum.

appendix there is an increase in the number of goblet cells. This is, however, what one would expect. A routine examination of a large number of appendices reveals many specimens containing a marked increase in this type of cell without any retention of the secretion.

Little or nothing may be complained of by the patient. In the uncomplicated cases the symptoms when present are always those of a chronic lesion. None of these presented a rise in temperature or leucocytosis. They complained of intermittent attacks of pain referable to the appendix, accompanied by tenderness and sometimes nausea and vomiting. No symptoms whatever were complained of in two of my cases—one a hydrops, the other a mucocele. Both of these specimens were accidentally found at autopsy.

One of the complications most writers mention upon this subject is rupture of the cyst. It did not occur in this series. This may be possibly accounted for by the fact that none of these specimens had attained the enormous proportions described in some instances. Another and more frequent complication is a pyogenic infection superimposed upon the already cystic appendix. This complication occurred once in this series (Fig. 1). This was the case of a young man of twenty-seven, who came to operation because of the classical signs of acute suppurative appendicitis. The patient had had a similar attack of pain one year before, without a rise in temperature or an increase in the white cell count.

While none of these seven appendices presented the great size which has been recorded by certain authors, they are definite retention cysts of the organ. When taken together with many smaller dilatations which have been frequently encountered in healed (Fig. 2) lesions of the appendix they make an interesting group for study. The largest of these was 10 cm. in length and 6.5 cm. in circumference.

Apparently no characteristic shape can be ascribed to these specimens. The contour is, as a rule, regular and the surface smooth. Occasionally two cysts are found in the same specimen. In one instance there was a small cystic dilatation, occupying the first one-third of the appendix, following this a complete obliterative constriction and next a larger dilatation of the remainder of the organ. Subcysts and bosses may also be present.

Four of this series presented complete obliteration of the lumen proximal to the cyst; in three the lumen was found to be patent throughout. Six of the seven specimens presented adhesive bands more or less constricting their lumina.

The location of the obliteration appeared to be a definite factor in

# CYSTIC DILATATION OF THE VERMIFORM APPENDIX

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WHILE by no means unique, cystic dilatations of the vermiform appendix are sufficiently rare, at least in the literature, to warrant a careful study of every available case. Dodge,<sup>1</sup> after a careful review of the literature, collected 142 cases and gave the percentage of incidence as ranging from 0.2 to 0.68 per cent. Undoubtedly in surgical practice this condition is encountered more frequently than the above statistics would indicate. Since the appearance of Dodge's paper, Graves<sup>3</sup> has reported two cases, Bailey<sup>2</sup> a case, and Ginsburg<sup>4</sup> another case.

It has been my privilege to make an intensive study of seven definitely cystic dilatations of the appendix found in the Museum of Pathology at the Ohio State University. Two of these were true hydrops of the appendix. The contents of the other five cysts were of mucoid materials.

It would appear that this condition may occur at any age, excepting possibly in the very young. It is well to remember, however, that the majority of these are discovered in the more active decades of life.

In the series to be discussed, sex apparently played no important rôle. Four occurred in men and three in women. This agrees with the cases collected by Dodge in which the sex was mentioned; 37 were in males and 24 in females.

Definite etiological factors capable of explaining each individual case cannot be stated. Partial and complete obliterations of the lumen, however, certainly played a very important rôle. It would seem impossible to find a true hydrops of the appendix without complete occlusion of the lumen. Two of the specimens in this series presented a condition of hydrops. In both instances the occlusion was complete. It is apparent, however, that this is not the only factor at work in the production of cystic conditions, since many specimens are encountered in which kinks, acute angulations, and complete obliterations are present without even a suggestion of cystic dilatation.

On the other hand, cystic formations, excluding hydrops, can occur in the appendix without obliteration of the lumen. In mucocele of the



FIG 5 —A mucocoele of the appendix with its coagulated contents.



FIG. 1.—A specimen of true hydrops of the appendix in which a suppurative inflammation was superimposed. The portion showing the complete obliteration had been removed.

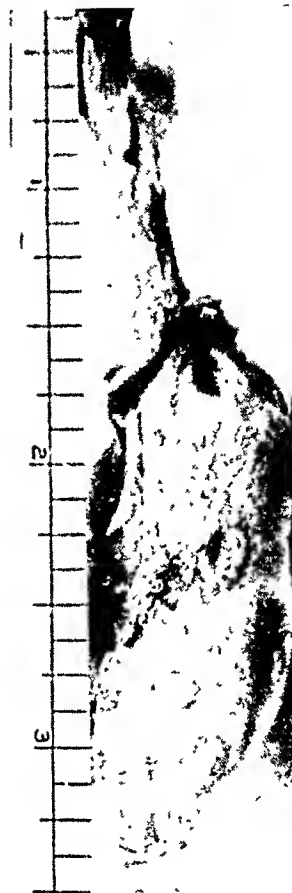


FIG. 3.—A specimen of hydrops of the appendix removed at autopsy. Note the constricting band.

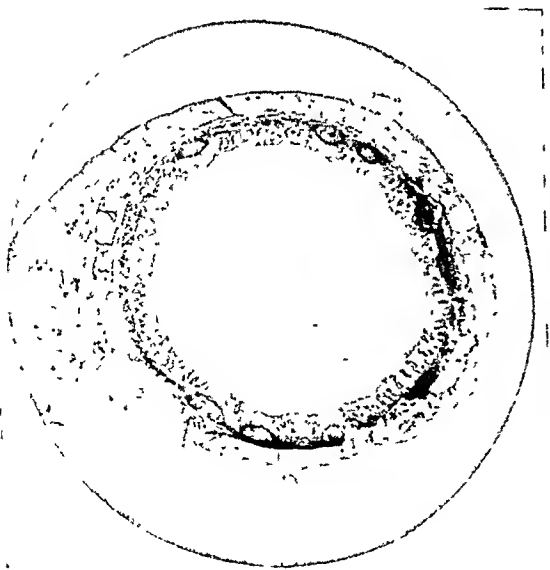


FIG. 2.—A cross-section of one of the smaller dilatations which are frequently encountered associated with obliterative lesions ( $\times 5$ ).

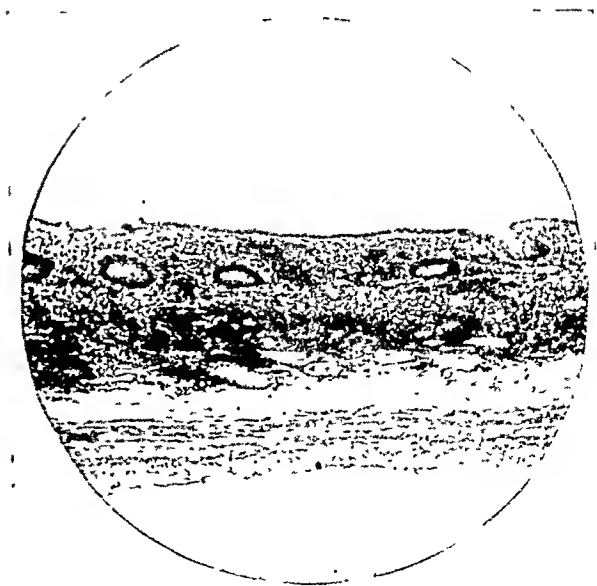


FIG. 4.—Wall of specimen shown in Fig. 1. Note the absence of the longitudinal muscle layer ( $\times 2$ ).



The author would here express his thanks to Doctors C. W. McGavran, John W. Means, and V. A. Dodd for the use of their material and to Doctor Jonathan Forman for assistance in the collection of specimens and many valuable suggestions during the progress of this study. He is also indebted to Doctor C. Claron Hugger for the photographs.

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determining the shape of the cyst. In case the obliteration was at the cæcal extremity of the appendix, the shape of the organ was more or less retained. In one instance, however, an obliterating band passed over the appendix at about its middle, producing an egg-shaped cyst (Fig. 3).

The contents of five of these cysts were mucoid in character, while the contents of the other two were serous. Both of these latter specimens were associated with a marked thinning of the wall, as is frequently found in other hydropic conditions (Fig. 4). In both specimens also there was complete occlusion of the lumen. Indeed, it would be difficult to understand how a fluid of a serous nature could be retained in case the lumen were patent.

The microscopical picture of this condition seems to vary according to the length of time the process had been going on, the presence of complete or partial occlusion of the lumen, and to the nature of the contents. The epithelium lining the appendix varies. Many of the cells may be greatly swollen, due to an increased amount of mucin contained within the cell body (Fig. 5). This can be rendered strikingly prominent by the use of the mucicarmin technic. The increase of these goblet cells would seem to be a fairly constant phenomenon in the formation of an appendicular mucocele.

In cases where the appendix is greatly dilated, forming a cyst under considerable pressure, the mucosa becomes thinned out. It loses the tubular arrangement of its glandular structure and the cells become flattened. A diminution of the lymphoid tissue was found in all the specimens varying with the degree of dilatation. The connective tissue present varied with the amount of inflammatory reaction which had taken place and with the degree of tension to which the wall had been subjected. The muscularis mucosa in the earlier and smaller dilatations may be hypertrophied, but later as the size of the cyst increases it atrophies and disappears. With this increase in pressure the muscular coats atrophy, leaving only a thin wall of connective tissue. In my specimens, the longitudinal coat disappeared before the circular layer of muscle fibres. None of the coats showed an infiltration of any type except when complicated by an acute infection.

**SUMMARY.**—Cystic dilatations of the appendix are not infrequently encountered. True hydrops of the appendix is by no means as frequent in this organ as other types of cystic dilatation. This condition of hydrops is constantly accompanied by a complete obliteration of the lumen. Bands, adhesions, and other obliterative lesions apparently play a very important part in the production of these cysts.

would be in one leg and then again in the other and then perhaps in both.

One-eighth to one-quarter grain of morphine was required once or twice a day, in order to make the condition of the patient bearable. If the patient kept entirely still, lying quietly upon his back, the pain was relieved. There was no disturbance of sensation, either tactile or for heat or cold. The patellar reflexes were slightly exaggerated. He had trouble in urinating. The catheter was never necessary, but it took him considerable time to get the urine started. He had trouble in moving his bowels, because every effort increased the pain in his back. The spinous processes of the lumbar vertebræ were sensitive to pressure and the spine was rigid.

On July 7 an X-ray picture was taken of his spine with the light focused at about the twelfth dorsal vertebra. The plate shows the fourth and fifth lumbar to be clear and distinct in outline. From this point up to about the tenth dorsal the outlines of the vertebræ are very indistinct and hazy, while the intervertebral cartilages between the second and third lumbar seem very much thinned, especially on the left side.

A diagnosis of typhoid spine was made, and on July 11 a plaster case was applied, with the patient supported in an upright position from the head and arms by a tripod and Sayre's apparatus. At this time the patient could not stand, and had to be carried from the bed to a stool placed under the tripod.

For a few days after the application of the plaster case he seemed greatly relieved, and then the pain returned. He then complained of the motion between the lower lumbar vertebra and the pelvis. The pelvis was not fixed, the case only reaching to the upper part of the iliac crests. He also made complaint that the case was too loose.

On August 3 a second case was put on, rather snugly, and brought down far over the iliac crests. Relief was immediate. On August 17 and 18 he sat up in a chair, and on August 19 walked across the room. August 20 he complained of pain in his back and across his hips, this continued for three or four days. He was then kept in bed for ten days, after this he sat up each day and had no further pain.

On September 17 he went downstairs and came back without assistance. September 20 he went out of doors.

On October 13 he had gained so much in weight that the case was interfering materially with his breathing, and it was removed and a new case applied.

He had had no pain since August 24, and on December 1 went to work, having no discomfort of any kind, feeling strong and well and able to walk miles.

## REMARKS ON TYPHOID SPINE

WITH REPORT OF A CASE

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CASE REPORT.—The patient was a man thirty years of age, who had never been ill until taken with typhoid fever, February 7, 1916. Widal positive. Fever continued for five weeks. Highest temperature was  $103^{\circ}$ . May 1, thereafter, after commencing work as a book-keeper, he complained of stiffness in his back. His feet seemed heavy and he was unable to lift them readily. When getting on a car he was obliged to pull himself up by his hands. Articles that he could easily handle before he was sick he found very heavy, and when trying to lift them he complained of pain or a kink in his back. He was unable to lift his ledger from the safe on to his desk.

On June 10 he came home from work complaining of headache and a terrible pain in the small of his back. His temperature was  $100^{\circ}$  F. During the following week the pain continued, while his temperature varied between  $100^{\circ}$  and  $102^{\circ}$ . In the second week his temperature reached  $103^{\circ}$  and he complained of severe pain below the right costal arch, and here a pear-shaped body could be felt which was very sensitive to pressure. In the third week the pain in the gall-bladder and the fever gradually disappeared, but the pain in his back continued.

During this time he was confined to the bed and could not raise himself into an upright position, but had to turn on his side and slide out. The pain was situated primarily in the lumbar region and was often like the stabbing of a knife. Later it seemed to localize in the iliac crests, first on one side and then on the other. It was brought on by any motion transmitted to the spine, such as turning in bed or in making an effort to rise. The pain was spasmodic in character, at times lasting but for a moment or two and then again continuing intermittently for half an hour or half a day. If he sat up he was obliged to place his hands on his hips or knees or on a table for support.

During these attacks the pain would often extend down the front of his thighs, when the muscles would be suddenly contracted, the thighs drawn up, and the knees flexed. During other attacks the pain would extend along the posterior region of the thighs, then the limbs would be extended and the toes turned down, toward the sole. At times these forcible contractions

Spondylitis deformans usually occurs in men and especially in those who have performed hard manual labor. There is an absence of fever, the condition is slowly progressive. The patients are usually past middle life. There is often kyphosis, which may involve the entire spine. The spine is more or less rigid and other joints are frequently involved, such as the shoulder and hip and those between the ribs and vertebræ. The latter condition may interfere with respiration. Enlargement of the transverse and articular processes can often be demonstrated by the X-ray.

Tuberculosis of the spine is most frequent in children and young adults. It may follow an injury. The patients have a characteristic gait of careful locomotion with rigid spine. There is often hectic fever, with night sweats, general weakness and wasting, pain in the spine and later kyphosis.

Tumors of the spine, excepting metastatic growths, are extremely rare. Two or three years following excision of the breast for carcinoma, metastasis to the vertebra producing symptoms not unfrequently occurs. These growths produce most agonizing root pains, with marked rigidity of the spine and sensitiveness of the spinous processes. The slightest motion transmitted to the spine causes unbearable pain. The important point here in the diagnosis is that the patient has or has had a malignant growth.

*Pathological Anatomy.*—From a reading of the literature of typhoid spine and from the study of my own case, I feel confident that there is in this condition an acute infection of the periosteum and bone, an acute osteoperiostitis.

This infection, followed by inflammation and softening of the vertebra, may lead to a crushing of the bone or bones by the superincumbent weight of the body. At the same time as the result of infiltration, softening and pressure, the intervertebral cartilages may become thin and partially disappear.

In 9 necropsies, Quincke found typhoid bacilli 8 times in the marrow of the ribs and once in the bones of the extremities.

Fraenkel examined the marrow from the bodies of the vertebræ in 10 cases, and from each typhoid bacilli were cultivated.

In the treatment, the patient should be given considerable quantities of fresh water, in order to flush and in so far as possible wash the infection out of the system. In some cases, drainage of the gall-bladder may be necessary. The second indication is to put the patient at rest, after thoroughly immobilizing the spine in extension. Early immobilization relieves or lessens pain, prevents deformity, and tends markedly to shorten the process of inflammation by preventing irritation and injury.

## TYPHOID SPINE

On February 10 the case was discontinued. At this time a second X-ray was taken, which showed the vertebra much more distinct in outline, but a thinning of the intervertebral cartilages between the twelfth dorsal and first lumbar and between the first and second lumbar.

The condition of typhoid spine was first brought to the attention of the profession by Virgil Gibney, in 1889.

John B. Murphy, in *Surgery, Gynecology and Obstetrics*, for August, 1916, in an article on bone and joint disease, the result of typhoid fever, states that in 452 cases of typhoid bone lesions the spine was affected in 108. In 533 typhoid bone lesions, the bones of the head were implicated 22 times, spine 110, thorax 142, upper extremities 57, lower extremities 83, multiple bones affected 19 times.

The ribs, tibia and spine represent 70 per cent. of all cases. In the spinal cases the cervical region was involved in one case, dorsal in 8, dorsolumbar 10, lumbar 59, lumbosacral 6, and sacral 4. There was deformity in 17 out of 59 cases.

In the great majority of cases of typhoid spine, the first symptom of importance is pain in the back, and in more than one-half of the cases the pain is situated in the lumbar region. The pain is greatly increased by motion and is often spasmodic. The abdominal muscles may be implicated but more frequently those in the lower limbs are affected. There is frequently a girdle-like sensation about the body and there may be hyperæsthesia of the skin. The pains often radiate to the iliac crests, groins, or down the limbs. There may be incontinence or an inability to empty the bladder. Incontinence has occurred in one-third of the cases. Typhoid spine should be differentiated from lumbago, spondylitis deformans, tuberculosis of the spine and tumors of the vertebræ.

Among the important considerations in the diagnosis of typhoid spine are the following:

The patient has had an attack of typhoid fever. The pains are root pains. The spine is rigid and the spinous processes of the affected region sensitive to pressure. The gall-bladder is often infected and fever is frequently present.

The condition of typhoid spine may make itself manifest during the attack of typhoid fever or a few weeks afterwards or even some months following the attack.

Lumbago is to be differentiated by the facts that the pain and stiffness are confined to the lumbar muscles. The condition is transient, but likely to recur. There is an absence of fever and the pain is relieved by heat and antirheumatic remedies. In lumbago the pains are muscular.

scapula was performed, employing nitrous oxide and ether anæsthesia, with practically no bleeding in the wound. He received daily injections of 10 c.c. of antistreptococcic serum, on April 11, 12 and 14. The wound continued to discharge profusely—however, healing over sufficiently to allow the patient to be discharged from the hospital on April 27, when he was referred to the Out-Patient Department for further treatment. Now the denuded surface has completely healed, and the patient has returned to work.

#### GUNSHOT WOUND OF THE THIGH: GAS BACILLUS INFECTION

DR. NATHANIEL GINSBURG presented a patient who had received a load of bird shot, at close range, into the femoral region of the right thigh, on October 12, 1916. He was admitted into the Jewish Hospital one hour later with a large, punched-out wound, corresponding to the saphenous opening, about four inches in diameter and involving the entire thickness of the thigh in this region. The patient was considerably shocked, with rapid and feeble pulse, and presented evidence of the loss of considerable blood. He was bleeding freely upon admission, the hemorrhage being controllable only by gauze packing introduced into the wound. Fifteen hundred units of tetanus antitoxin were injected and the wound was thoroughly cleansed with pure tincture of iodine. The femoral sheath, with the visible pulsating femoral artery, was thoroughly exposed and had miraculously escaped penetration by the shot. The long saphenous vein and the superficial and deep external pudic arteries and the obturator vessels had apparently been opened by the wound inflicted. The X-ray examination the following day (October 13) showed a great number of small shot embedded in the thigh against and surrounding the obturator foramen. There were numerous shot scattered in the lower gluteal region. In the evening of this day, the foul odor, characteristic of gas bacillus infection, attracted attention and an examination of the wound revealed gas bubbles with crepitation of the surrounding tissue. Dr. David Riesman, who saw the patient, concurred in the diagnosis of gas bacillus infection.

Under nitrous oxide anæsthesia, a fenestrated rubber tube was introduced into the wound, passing completely through the adductor region of the thigh, and irrigation was begun, employing a fifty per cent. hydrogen peroxide solution, alternating with a solution of Bulgarian bacilli every two hours. The infection was apparently confined by the intermuscular septa of the thigh, which enclose the muscles of the median osteofascial compartment, and did not spread beyond this

# TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting, held February 5, 1917*

The President, DR. CHARLES H. FRAZIER, in the Chair

## SCAPULOHUMERAL AMPUTATION FOR GAS BACILLUS INFECTION

DR. NATHANIEL GINSBURG presented a patient who was admitted into the Mt. Sinai Hospital, March 22, 1916, with a traumatic amputation of the left arm about 7 cm. from the shoulder-joint. The extremity had been accidentally introduced into a knitting machine, which caused the injury. Upon admission the patient was immediately taken to the operating room, and disarticulation of the left shoulder-joint was performed. Extensive laceration of the soft tissue about the remains of the shaft of the humerus precluded any attempt to save much of the extremity. The wound was thoroughly disinfected by mechanical cleansing, and by the application of iodine to the lacerated tissues. The shoulder flaps were loosely sutured and a rubber drainage tube, introduced into the glenoid cavity, emerged at the lower angle of the wound.

Thirty-six hours after the amputation, the patient's temperature rose to 105°, accompanied by a rapid and thready pulse of 132. The wound discharge was foul, of the characteristic odor of gas infection, and the flaps were discolored by beginning gangrene. On the following day the shoulder flaps were black, with foul odor and profuse discharge from the wound. The wound was completely opened, exposing the glenoid cavity, bubbles of gas discharging freely at this time. The skin over the entire left chest was discolored and crepitant. Cultures from the wound showed the presence of the *bacillus aerogenes capsulatus* and the tetanus bacillus.

Irrigation of the wound with a fifty per cent. hydrogen peroxide solution alternating every two hours with a 1-4000 bichloride solution was begun. Extensive necrosis took place, resulting in total loss of the flaps enclosing the glenoid cavity, and spread dorsally until the entire surface of the scapula was exposed, as though it had been cleared by a dissecting-room scalpel.

On April 10, nineteen days following the injury, excision of the



washed out with a sherry-colored solution of tincture of iodine in water. The patella was broken into probably a dozen fragments, and two or three small detached fragments were removed. The aponeurosis had been lacerated over the bone and torn down toward the external condyle. It was brought together with mattress and interrupted sutures of chromic catgut. Two rubber drainage tubes were inserted in the outer angle of the wound, one extending into the joint, the other to the opening in the joint capsule. The skin wound was sutured except for the drainage track and the traumatic wound, which latter was drained by a piece of rubber tissue. The leg was dressed on a posterior splint and the patient given antitetanic serum.

The convalescence was uneventful. An X-ray taken after operation showed good approximation of the fragments. The splint was removed after four weeks and the patient left the hospital on November 1. There was then about one-third the normal amount of flexion present in the knee and she was able to walk on crutches. She has now regained very fair use of her knee, is able to bear her weight on it, and has good range of motion, flexion being possible to a right angle, and still improving.

This case illustrates among other things the method of treatment of compound fractures of any variety which Dr. Jopson has found most efficacious, namely, immediate transference to the operating room, etherization, sterilization as if for primary operation, followed by cleansing of the wound—sterilization, the introduction of drainage and whatever other measures may seem indicated. Since adopting this plan his results in the treatment of compound fractures have been vastly improved, and severe infections are a rarity.

Compound fracture of the patella is an unusual injury in civil practice. Of twenty-six recent fractures of the patella operated upon by him, this was the only instance in which the fracture was compound. This series was operated without mortality and without joint infection. Stimson has emphasized the fact that patellar fractures are generally compound by reason of external violence, except in those instances where refracture occurs after operation, and where the scar or the skin is tightly adherent to the surface of the bone. In such instances indirect violence may result in simultaneous fracture of the patella and tear of the soft parts covering the bone.

DR. NATHANIEL GINSBURG gave the history of a compound fracture of the patella which was operated upon by him on August 22, 1912, in the Philadelphia Polyclinic Hospital.

The patient was a fireman on a railroad engine, who fell from the

## COMPOUND FRACTURE OF THE PATELLA

region. Extensive necrosis of the muscles corresponding to this area took place.

On October 14, two days after admission, continuous irrigation of the wound with Dakin's solution was begun, the hydrogen peroxide solution being discontinued. The patient was extremely toxic, and intravenous injections of sodium bicarbonate solution were administered daily. Multiple incisions were made over the internal and posterior surfaces of the thigh, opening up the muscular spaces through which drainage was established.

Improvement slowly took place, large masses of necrotic material being removed from the wound and counter openings. On October 21, close application of electric light to the wound, without dressings, was maintained. In view of the fact that the process was now limited, and the patient's condition much improved, irrigation of the wound with a fifty per cent. peroxide of hydrogen, followed by a 1-8000 solution of nitrate of silver, was substituted for Dakin's solution.

The patient was discharged from the hospital November 6, 1916, with loss of the upper portions of the adductor and gracilis and pectineus muscles, and with slight discharge from the wound corresponding to the site of his injury. Numerous shot have been discharged from his gluteal wound since he left the hospital, but most of the bird shot still remain in his body.

Recovery in these two cases can be attributed to early and free drainage which was established, with the continuous irrigation of the wounds.

## COMPOUND FRACTURE OF THE PATELLA

DR. JOHN H. JOPSON presented a stout woman, fifty-six years of age, who was admitted to the Presbyterian Hospital in September, 1916, with a bad laceration of the face and a compound fracture of the patella, the result of having been struck by a street car. She was transferred to the operating room almost immediately. Examination of the knee disclosed an irregular wound over the patella, about one inch in length, running transversely. Through this could be palpated a comminuted fracture of the bone, which was broken into many fragments, and the finger passed directly through it into the knee-joint. The patient was etherized, and the entire region of the knee prepared for operation. The preparation consisted in cleaning the skin with benzene, alcohol and tincture of iodine. The wound was enlarged by lateral incisions, which were carried downward and outward to the condyles of the femur. The joint, when opened, was thoroughly

formalin in glycerin solution were injected. The temperature immediately dropped to  $99\frac{2}{6}^{\circ}$ .

The day following the aspiration of the joint, a large submuscular abscess of the lower third of the right thigh was incised, employing local anæsthesia. This infection was associated with the purulent joint effusion, and probably was an extension of the same. The temperature subsided to normal thirty-six hours following drainage of the thigh abscess.

Longitudinal traction was applied to the injured leg upon his admission into the hospital, and was maintained until the open operation upon the patella was performed. Drainage from the thigh wound and from the needle puncture wound into the joint continued for some weeks. On October 25, about seven weeks after his admission into the hospital, his wounds had completely healed. It was now deemed advisable to attempt to bring the patellar fragments together. The operation was performed during one of the clinics for the physicians attending the Clinical Congress of Surgeons then meeting in Philadelphia.

Under gas-ether anæsthesia, a vertical incision was made over the right patella extending from the quadriceps extensor tendon above to the tubercle of the tibia below, and the interior of the joint was exposed. There was considerable capsular and aponeurotic thickening with fibrous induration of the blood-clot which existed between the two fragments. Both fragments were immobile, and could not be apposed in the slightest degree. The joint cavity above the line of fracture was considerably diminished by the firm application of the upper fragment to the femoral surface, owing to the contraction of the quadriceps extensor muscles and the lateral ligaments.

The periosteal attachment of the ligament of the patella was chiselled off the tibia, carrying with it a small fragment of cortical bone. This did not lessen the difficulty, since the lower fragment remained immovable, owing to the induration and diminished elasticity of the patellar capsule and the lateral aponeurotic expansion. The lower fragment was completely excised and lifted out of the wound. The wound clot was dissected, and, after freshening the fracture surfaces, the excised fragment was brought in contact with the upper fragment and held there by a phospho-bronze wire suture passed through the patellar capsule. The lower fragment was fixed on a higher level by interrupted chromic catgut sutures to the aponeurotic expansion from which it had been dissected, and the lateral ligaments and patellar capsule of the knee-joint were also sutured by interrupted

## OLD REFRACTURE OF THE PATELLA

tender, striking on the right patella. He was operated upon immediately on his admission to the hospital, and the patella was found to have been fragmented into four pieces, with a wound communicating with the interior of the joint. At operation, one fragment was found lying free in the joint cavity, which was removed, and another small fragment, which could not be satisfactorily placed in relation to the other pieces of the patella, was excised. The joint was irrigated with a 2 per cent. formalin solution, followed by sterile water, and the remaining fragments were apposed by a bronze wire passed through the ligamentum patellæ below the quadriceps extensor tendon above. The capsule was sutured as well as the lateral ligaments, the joint being closed without drainage. The leg was immobilized by a posterior splint, in addition to traction, employing twenty pounds of weight.

On the day following the operation, the knee-joint was aspirated and about 200 c.c. of serosanguineous fluid were removed, and 15 c.c. of a 2 per cent. formalin-glycerin solution were injected. The patient was discharged from the hospital on September 28, with good union of the patella. The highest temperature during his stay in the hospital was 99°, and the pulse-rate never rose above 98.

He has been unable to trace the patient since his discharge from the hospital, but there is every reason to believe that he has a good functional knee-joint, since he had a satisfactory operative recovery, and no infection resulted following the injury.

## OLD REFRACTURE OF THE PATELLA, WITH SUPPURATIVE ARTHRITIC EFFUSION, AND RESECTION AND TRANSPLANTATION OF THE LOWER FRAGMENT

DR. NATHANIEL GINSBURG presented a man who was admitted into the Jewish Hospital, September 7, 1916, and discharged December 22, 1916. Four months previous to his admission, the patient sustained a fracture of his right patella, which was sutured in another hospital, the fragments not having been wired. He tripped over a curbstone, and fell to the ground, striking his right knee, and sustaining a refracture of the patella, on September 7, 1916. Examination showed a transverse fracture of the right patella, with about five centimetres' separation of the fragments. On the following day a sudden rise of temperature occurred, which reached 103° September 10, seventy-two hours after admission.

On September 11, an examination of the knee-joint suggested the presence of a purulent effusion. The joint was aspirated, and 90 c.c. of pinkish purulent fluid were withdrawn; and 14 c.c. of a 2 per cent.

shifting to the umbilicus. Repeated previous gastric analysis had shown low total acidity, low free hydrochloric acid, contents usually alkaline; there was no food retention. The X-ray studies had resulted in a diagnosis of pyloric ulcer by the röntgenologist, but there was no food relief, no pain late after food ingestion. There was now no leucocytosis and no jaundice. Shortly after admission to the hospital, a sharp attack of generalized abdominal pain occurred with persistent vomiting. Lavage of the stomach brought brownish material with a fecal odor. The bowels moved freely immediately afterwards and there was no further vomiting. The condition was now evidently one of partial obstruction. No pelvic lesion was present except a very small movable nodular mass in the region of the right ovary, which was not accounted for. There was frequent urination and much bladder irritation. The thighs and vulva were inflamed and incrustated from urinary contact. There was no incontinence. Because it was necessary to explore both the upper and lower abdomen, the incision was made to the right of the navel and extended upward and downward as required. The gall-bladder contained more than one ounce of bile; was compressible, moderately adherent, its walls a trifle thicker than normal and of a dull brown color, which indicated a low degree of chronic inflammation. No stones could be felt. The pylorus was thoroughly exposed and palpated, but no thickening or other evidence of disease could be demonstrated. There were no adhesions. The appendix was long, passed behind the cæcum, and had no meso. It was removed after splitting the outer mesocolon, cutting off the base first and gradually working down to the tip. Adhesions in the neighborhood had formed a well-defined Lane's kink which was released. A congenital fold of peritoneum passed downward from the root of the appendix to the pelvic wall at the insertion of the infundibulopelvic ligament. That was ligated and incised. Further exploration revealed about two feet from the ileocæcal an angulated knuckle of small bowel, infiltrated over an area of an inch or more in diameter. There were no neighboring adhesions. The bowel was separated and brought into the wound which produced a fistulous opening. The intestine was larger above than below the site of partial obstruction. The mesentery was thickened, but not hard, near the insertion into the bowel. About 8 inches of small intestine was resected, the ends being burned off with the cautery and turned in with catgut, afterward being covered with Lembert suture of celluloid linen. Side-to-side anastomosis was then performed by suture. The infiltrated point of the bladder showed excavation which did not at this time perforate the mucous membrane, though

## CHRONIC PERFORATING ULCER OF SMALL INTESTINE

chromic catgut sutures. The joint was immobilized by a plaster casing extending from the upper thigh to the lower leg, which was worn for four weeks.

With the exception of some slight superficial wound discharge, convalescence was uninterrupted and the patient was dismissed from the hospital on December 22, 1916, with union of the patellar fragments and sufficient flexion and extension of the leg to allow him to act as an orderly in the hospital. The X-ray examination of both knee-joints shows the superior position with relation to the femoral condyles occupied by the injured patella.

DR. JOHN H. JOPSON said that some time ago he showed before the Academy a case of old fracture of the patella in which there had been much difficulty in approximating the patellar fragments. A plastic operation on the quadriceps tendon was performed, and an elevation of the tubercle of the tibia after the method of von Bergmann, after which the fragments could be brought in apposition and wired. Firm union was secured. Dr. Ginsburg's method amounts to a free transplantation of the lower fragment and the result is excellent. He would much prefer this method to the use of a bone inlay as suggested by Albee, as he believes convalescence would be much shorter and the resulting union stronger.

## CHRONIC PERFORATING ULCER OF THE SMALL INTESTINE, INVOLVING THE BLADDER WALL

DR. GEO. ERETY SHOEMAKER presented a woman fifty-three years of age, who had been operated upon by him December 4, 1916, for the relief of ulcer and partial obstruction of the small intestine, chronic appendicitis, chronic cholecystitis. The patient was very stout and for a number of years had had pain and abdominal distention with occasional nausea and vomiting without definite localization as to origin. She had been in the Medical Wards of the Presbyterian Hospital twice under suspicion of pyloric ulcer. Definite symptoms associated with that condition were, however, wanting. The obscure attacks continuing, she was admitted to the reporter's service for exploration on recommendation of her physician.

Patient had formerly weighed more than 200 pounds, but had lost 47 pounds, and claimed to be unable to eat general diet without bringing on attacks of severe abdominal cramp-like pain, with difficulty in moving the bowels. There was no history of jaundice; the pains never went to the right shoulder and were never located in the gall-bladder region. They had only lately been in the right lower quadrant,

The next day the baby showed evidence of excessive weakness and died a few hours later.

At postmortem the peritoneum was everywhere glistening and showed no evidence of peritonitis. The gastrojejunostomy was mechanically satisfactory. The pyloric canal for a distance of about an inch was tightly constricted, as had been observed at operation, by a thickened muscularis measuring 6 mm. in depth at its thickest part. There was no apparent œdema. The longitudinal incision through this part of the muscularis was made after removal of the specimen and shows beautifully the distinctness of the separation of the muscularis from the submucosa and the elasticity of the latter, thus illustrating the ease and effectiveness of a Rammstedt procedure which was considered but not practised in this case. It shows also the sharp limitation of the muscular thickening to the gastric side of the pylorus, an important point to observe in performing the Rammstedt operation, because of the ease with which the duodenum may be opened.

The case illustrates the fact which has been pointed out by Holt, Downes and others, that sudden collapse may occur in these weakened infants with or without relief of the obstruction, and shows the advisability of resorting to surgical measures at an early period.

#### ILLUSTRATION OF A DISSECTION SHOWING A UNIQUE CONCEPTION OF DIRECT INGUINAL HERNIA

DR. P. G. SKILLERN, JR., presented the specimen shown in Fig. 1.

#### SURGICAL EXPERIENCE AND SURGICAL KNOWLEDGE

DR. JOSHUA EDWIN SWEET delivered the *Annual Oration* before the Society—the title of his address was as above, and the address will be found on page 673.

## CONGENITAL PYLORIC STENOSIS

it may at some time have done so. The diseased area was excised, the bladder wall sutured with two rows of chromic catgut. An abdominal cigarette drain was introduced near the site of the intestinal anastomosis. A retention catheter was placed in the urethra. There was no post-operative vomiting, no distention, intestinal gas passed freely. Bowels were moved by glycerin enema. There was a few drachms of purulent brown fluid at the drainage site by the third day; the drain was removed at this time and was not replaced. No gas and no fæces escaped at any time. The external irritation from the urine rapidly cleared up.

The convalescence was somewhat stormy due to the long-standing gastric catarrh with flatulence. The anastomosis never leaked; the wound healed solidly while in the hospital. Normal bowel movements were readily secured. The patient is now doing well, January 17, six weeks after operation. Cystoscopy by Dr. Laws shows bladder normal.

*Laboratory Diagnosis.*—Dr. Pfeiffer. Inflammatory infiltration and ulceration of bowel and bladder.

## CONGENITAL PYLORIC STENOSIS

DR. DAMON B. PFEIFFER presented a specimen of congenital pyloric stenosis. The patient was a girl, aged four weeks, the only child of healthy parents. At birth the baby weighed 7 pounds 13 ounces, and was apparently normal. For the first week the child took the breast and showed no digestive disturbances. During the second week she began to vomit occasionally. Various milk formulas were tried without effect and the vomiting grew worse while the baby lost weight rapidly. The bowels moved scantily. In the fourth week Dr. Charles A. Fife was called in consultation by the attending physician, Dr. George A. Parker of Southampton. Visible gastric peristalsis could not be observed at times, but no epigastric tumor was palpable. The child displayed evidence of ravenous hunger, taking food eagerly and sucking its thumbs. With the diagnosis of hypertrophic stenosis of the pylorus, the patient was referred to the Abington Memorial Hospital, for operation. The weight by this time was barely four pounds. The pulse was exceedingly thin and weak and the temperature subnormal.

Under ether anæsthesia, a posterior gastrojejunostomy was made without special difficulty. Hypodermoclysis was given during the operation and the patient left the table in good condition. She vomited once the following day and the stomach was washed out, a small quantity of biliary material being obtained. Feedings of whey were begun.





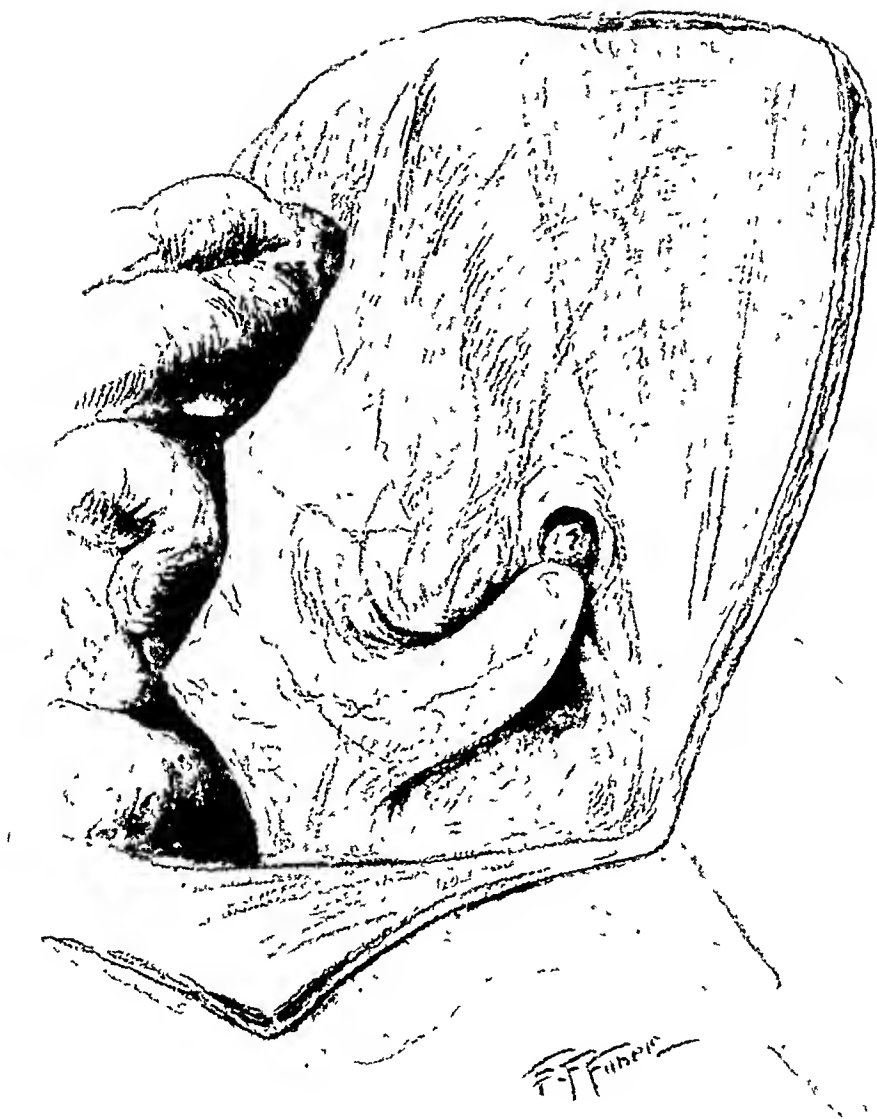


FIG. 1.—A unique exposé of direct inguinal hernia, chanced upon in the dissecting room of the University of Pennsylvania. On stripping the general layer of parietal peritoneum backward from the anterior abdominal wall in quest of the deep epigastric artery this finger-like hernial sac was revealed with its tip in the hernial orifice. Its connection with the general layer of parietal peritoneum was exactly like that of the finger of a glove to the rest of the glove. To show the hernial orifice the sac was drawn somewhat backward. Hesselbach's triangle is well shown, with the hernial orifice near its base.

with the common duct, as for a while bile was discharged freely. Notwithstanding this infection the wound healed kindly and he was discharged November 17, 1915. At present the wound remains solidly healed and there is no sign of hernia (Fig. 3).

CASE III.—Lawrence P., twenty-two years of age. Operated June 12, 1913. Laparotomy through upper right rectus for general peritonitis believed to be due to acute perforation of the stomach. Cause, however, was found to be an acute appendicitis. There was considerable infection of the abdominal wall resulting in much sloughing, and when patient was discharged August 4, 1913, there was a hernial protrusion through the scar size of two fists (Fig. 4).

On April 3, 1916, a similar operation as described above was performed. Here again there was a mild infection, but notwithstanding it the fascial edges united well and he is now, nine months after operation, in very good condition. Re-examination shows a perfectly firm scar.

#### OSTEOMYELITIS TREATED BY CARREL IRRIGATIONS FOLLOWING OPERATION

DR. GIBSON also presented the following cases:

Arthur H., eleven years of age. Operation October 23, 1916, for osteomyelitis of femur with removal of sequestra. The Carrel treatment was started seven days after operation and continued for twenty-five days (October 30 to November 25), when the wound having healed down to a narrow sinus, the last drainage tube was withdrawn. Discharged November 28, 1916.

At present the wound is firmly healed without any sinus.

Sylvanus C., twenty-one years of age. Extensive old osteomyelitis with necrosis of the upper third of the shaft of the tibia and entire head of the tibia. Sequestrotomy October 16, 1916, removing all the necrotic bone, leaving the head of the tibia only a thin shell. The Carrel treatment was started eight days after operation. To-day the whole wound is solidly healed with the exception of a narrow sinus admitting probe for about 1 inch.

Both these cases responded to the treatment with unusual promptness. There was at first a good deal of mucoid discharge such as is characteristic of all wounds treated by the Carrel method and particularly those connecting with bone. The bacterial count quickly and consistently came down to the zero level (Figs. 5 and 6). At no time did these wounds show the slightest evidence of suppuration. In the last case the result was unusually prompt and favorable. It has been rare, in his experience, that such a complete excochleation of the head of the tibia becomes filled up by healthy granulations and transformed into

# TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

*Stated Meeting, held January 8, 1917*

The President, DR. CHARLES N. DOWD, in the chair

## REPAIR OF LARGE INCISIONAL VENTRAL HERNIÆ BY PEDUNCULATED FLAPS OF FASCIA

DR. CHARLES L. GIBSON presented the following cases from the First Surgical Division (Cornell) of the New York Hospital:

CASE I.—Miss F., thirty-four years of age. In February, 1912, was operated for suppurative appendicitis. In April, 1913, was operated by Dr. Gibson for intestinal obstruction due to adhesions. Several feet of gangrenous lower ileum were resected and a side-to-end anastomosis made with the cæcum. There was an active peritonitis. Wound was left open in part and convalescence was effected only after marked suppuration of the abdominal wall.

On February 24, 1914, repair of ventral hernia was undertaken. After freeing the adhesions and refreshing the edges of the muscular and fascial layers it became evident that the edges could not be approximated even with undue tension. No other means of closing this large gap seemed available excepting by inserting a wire filigree. It was then determined to make releasing incisions through the outer border of the anterior sheath of the rectus on either side (Fig. 1). The free edges then could be readily approximated without undue tension in midline. The wound healed kindly. It is now nearly three years since operation and the abdominal wall is maintaining its integrity and the patient is able to perform severe muscular exertions without discomfort.

CASE II.—Nicholas W., forty-one years of age. Operated February 9, 1915, for cholelithiasis and stone in common duct. There was a severe infection of the abdominal wall, resulting in much sloughing, and when the wound closed there was a protrusion through the scar nearly the size of an adult head (Fig. 2).

On October 9, 1915, a similar operation as described above (Case I) was performed. There was a mild degree of suppuration, apparently due to the reopening of the sinus connecting



FIG. 2.



FIG. 3.



FIG. 4.

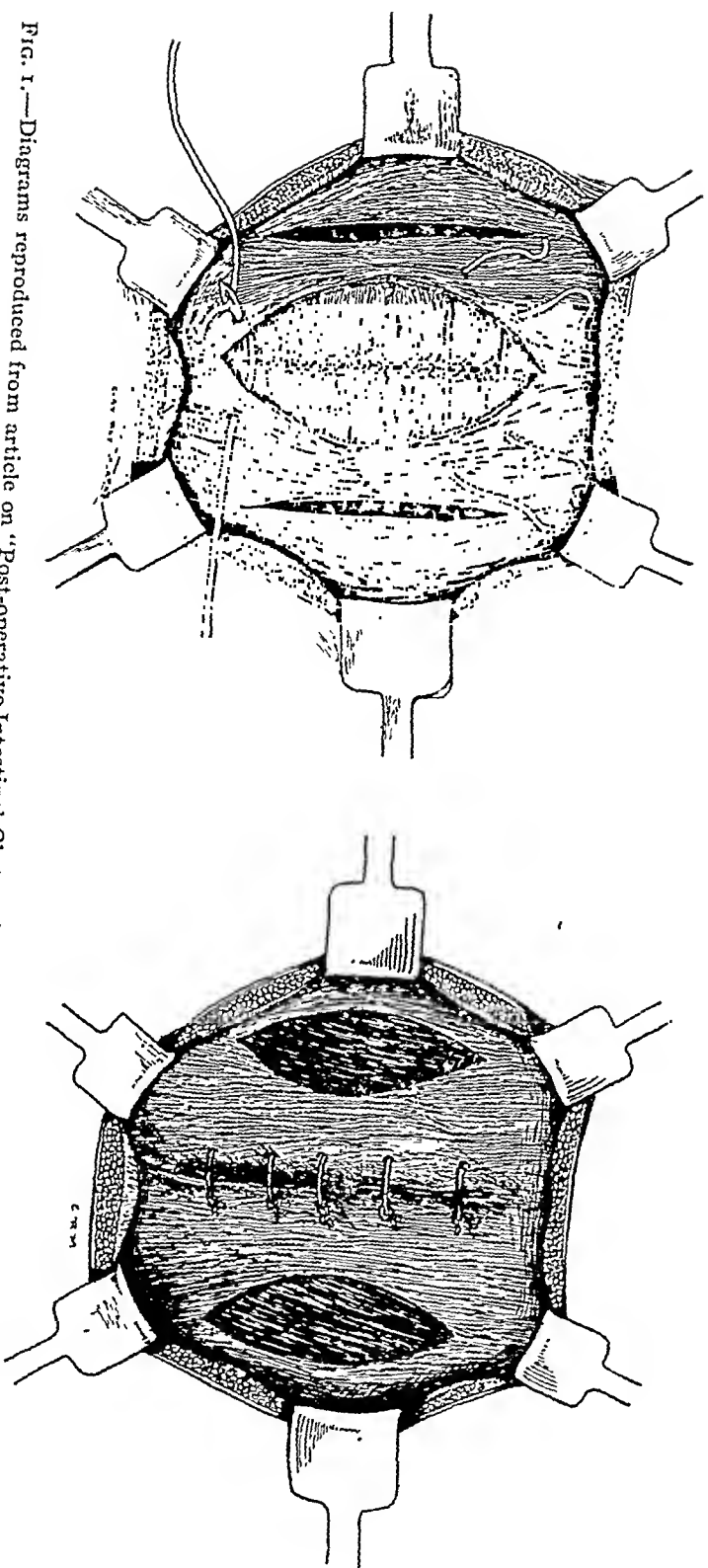


FIG. 1.—Diagrams reproduced from article on "Post-operative Intestinal Obstruction," *ANNALS OF SURGERY*, April, 1916, vol. lxiii, p. 443.

NEW YORK HOSPITAL.

BACTERIAL CHART.

History No.

Name, *Sylvanus P.*

Osteomyelitis of Tibia

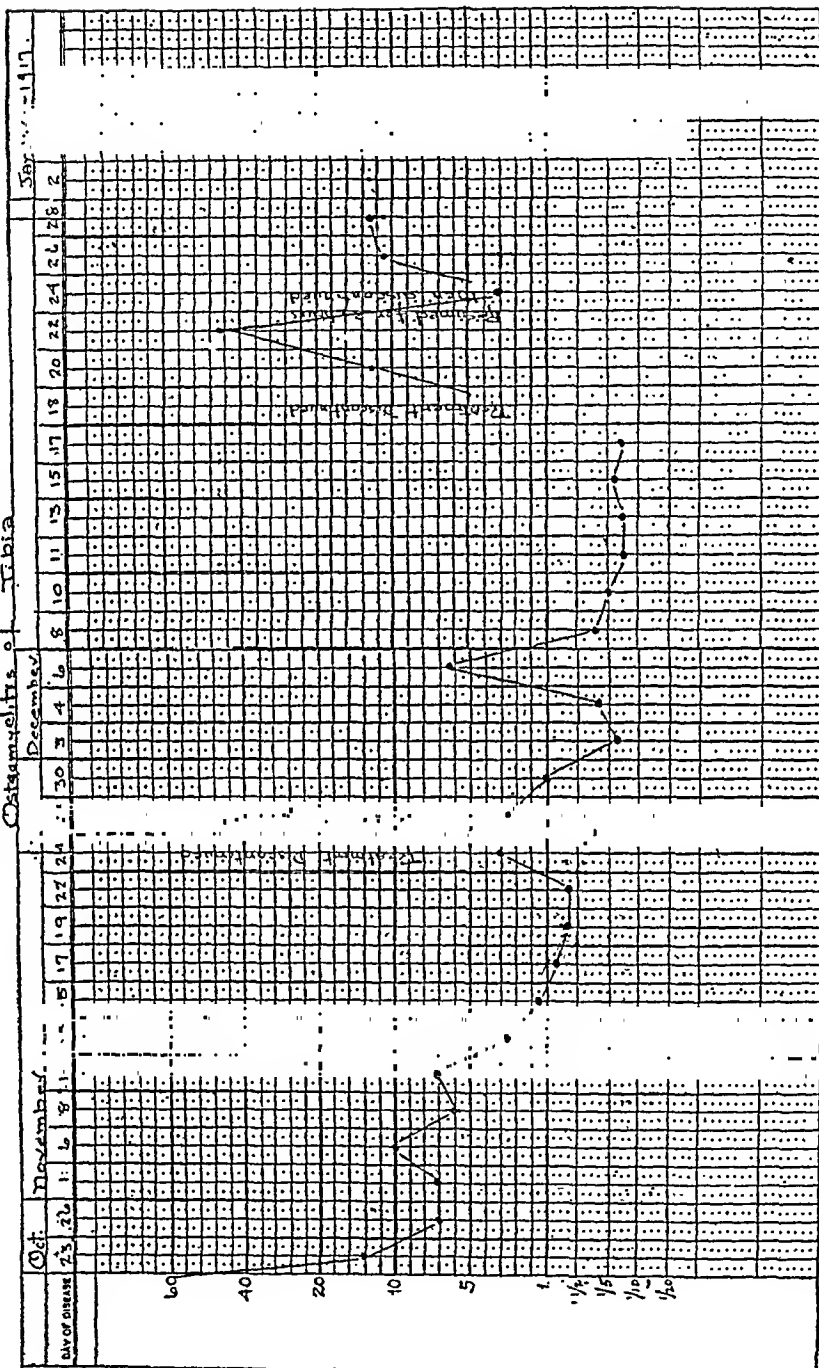


FIG. 6.

# OSTEOMYELITIS TREATED BY CARREL IRRIGATIONS

bone. These cases usually require secondary or plastic operations to close the bony defects.

DR. H. H. LYLE suggested the desirability of beginning the Carrel irrigations immediately after an operation.

Form 249

## NEW YORK HOSPITAL.

### BACTERIAL CHART

Name Arthur H.

History No. \_\_\_\_\_

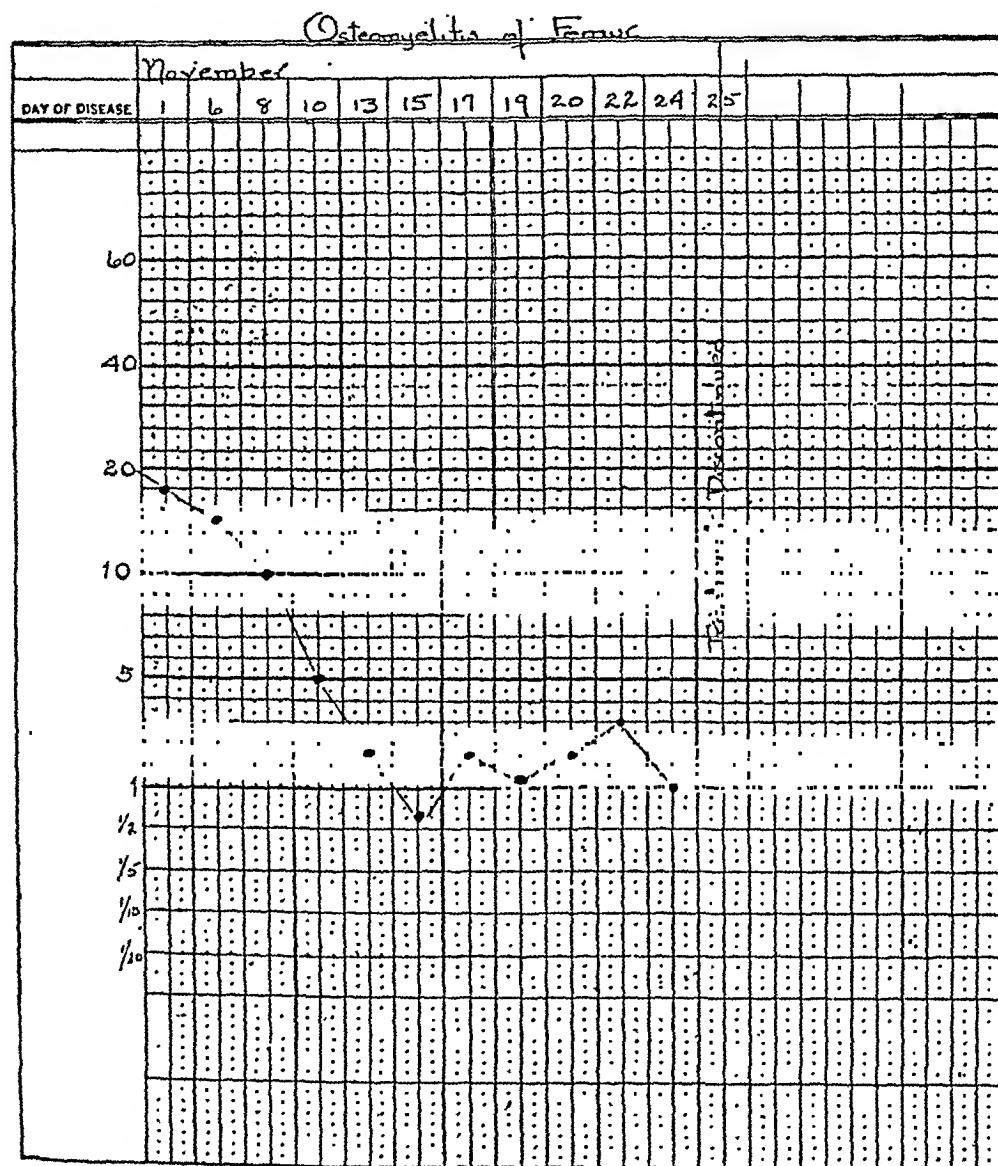


FIG. 5.

DR. HAWLEY said that he had about fifteen cases of chronic osteomyelitis under treatment by the Carrel method, all old and resisting cases. Most of them have been secondary, and perhaps five out of the fifteen are cured, old chronic osteomyelitis following compound frac-



These studies were published in the *ANNALS OF SURGERY*. The only thing that could be said was that so far as the experiment went, the dogs seemed to do better with a mediogastric resection than with some irregular form, proving that similarity to human action, but the why has entirely eluded them. They could not demonstrate why it should be better.

If anything, their cases seemed to move more regularly, more rhythmically, when there was a segmental resection than when an irregular resection had been performed.

### SPINAL CORD TUMOR

DR. ALFRED S. TAYLOR presented a woman, fifty-five years old, who for ten years had been excessively nervous, but otherwise well and strong. Fourteen years ago she fell from a street car, landing on her back and twisting her neck. The lameness had disappeared in a few days. Three years ago she noticed for the first time a pain in the mid-scapular region to the right of the spine, and this pain has persisted up to the time of operation. Two years ago she stumbled on getting into a car and fell full length.

In the summer of 1915, walking had become laborious and stair climbing very difficult. October, 1915, she developed a burning sensation in the left leg, which gradually spread until it involved both lower extremities.

On November 15, 1915, she waked up with a tight girdle sensation about the abdomen, which has persisted ever since. From that time walking became increasingly more difficult. There appeared in the lower extremities sensations of heat and cold, tingling and numbness. She could not distinguish between hot and cold objects, and could not tell whether her bath was water or sand. There soon developed difficulty in evacuating the bowel, although she had always been regular. The stools were not of constipated character, so that the difficulty was evidently muscular. There also appeared frequency of micturition with delay in starting.

Toward the end of January, 1916, she had a sensation of tight bands about the knees and ankles. About February 1, in attempting to enter a car, her feet would not lift and she fell. A few days later her legs gave out suddenly in crossing a street. From February 14 she had to remain in bed nearly all the time. After February 21 she could not move her legs even in bed.

The patient was a fairly nourished woman of fifty-five years; she was pale, the tongue coated and deeply furrowed; the eyes are normal,

## HOUR-GLASS CONTRACTION OF THE STOMACH

ture. While it is too early to say what the eventual outcome will be, he could say that under no method of treatment had he seen such fine appearance of the wounds. He had simply been following, as far as he could, what he had seen principally in Chutro's clinic in Paris at the Hospital Buffon, where he saw actual cases of chronic osteomyelitis cured and also a number of cases of septic arthritis.

He had two cases of septic arthritis of the knee which were doing very well. In no case is the septic process advancing; the temperature has dropped; there is no general appearance of sepsis; and the bacterial count has dropped down toward the normal line. He believed that this method was a step forward in the treatment of chronic infections of the bones and joints.

## HOUR-GLASS CONTRACTION OF THE STOMACH

DR. WILLIAM A. DOWNES said that about two years ago he presented a case of mediogastric resection for hour-glass contraction in which the immediate result was very satisfactory. At the time the question was raised as to the future condition of these patients in which completed division of the stomach wall had been made with end-to-end suture.

He now presented this same patient and three others upon which the same operation had been performed. The first one had gone three years, the second a little over two years, and the third and fourth only a few months. The result in each case has been most satisfactory, and apparently from recent X-ray plates these stomachs behave very much as do normal stomachs.

DR. GEORGE D. STEWART remarked that he had had some of these cases of mediogastric or segmental resection. Some of the operations were done for hour-glass contraction and some for plain gastric ulcer, because a good many men of wide experience seem to believe that segmental resection was superior to triangular resection or merely excising the ulcerated area.

It had seemed to him that the cases of segmental resection were better in their results than those in which the ulcer only had been excised. Dr. Barber and he had tried to prove or to demonstrate the reason. They did some experimental operations on dogs, and studied them by opening them up afterwards and watching the gastric motility. They studied them by persuading the dog (and a dog doesn't easily lend itself to this persuasion, even in the interest of science) to swallow a bag which was dilated in the stomach. They had some difficulty in getting it in and then getting it dilated. They studied the effect on the motion of the stomach of increasing the size of the bag.

The arachnoid was divided by scissors and the tumor carefully enucleated. It was so friable that it came out piecemeal, but was removed completely without damage to the cord to which it was not adherent. The cord had been compressed and pushed backward and to the left by the tumor, being most displaced opposite second dorsal spine. After the tumor was completely removed the cord still maintained its deformed position.

After careful hæmostasis the dura was closed by continuous catgut stitch and the remainder of the wound closed by layer sutures. No drainage was used.

*After Course.*—Healing was by primary union and the sutures were out on the fourth day.

For about three weeks her general condition was precarious, during which period cystitis with colon bacillus infection, tonsillitis, and a deep-seated pulmonary involvement which could not be made out for a number of days, all occurred. These complications were accompanied by low delirium, loss of sphincteric control, irregular temperature, and irritability.

During this period complaint of pain in the arms and in the wound led him to open it down to the dura to see if a deep infection might be the source of her troubles. The wound was perfectly clean and promptly healed again.

On the fifteenth day the delirium began to clear up and the general condition improved greatly. Thereafter improvement was continuous.

On the twenty-sixth day she sat up in a chair.

On the twenty-seventh day she stood up with some support.

On the twenty-eighth day she took three steps.

On the thirty-sixth day she walked well, sensation had returned to practically normal in both legs, and she returned home.

On July 8, 1916 (4 months 8 days after operation), she walked a mile out in the country.

She now walks about without fatigue and covers five miles or more every day.

The great nervousness, irritability and tendency to worry characteristic of the last ten years have entirely disappeared. There is now very slight increase in the knee jerks, but otherwise there is no remnant of the old symptoms. The right hand is slightly weaker than the left.

The promptness and completeness of recovery were largely due to the removal of the tumor before the complete paralysis had been long in existence.

It is interesting to note that there were two entirely separate tumors

## SPINAL CORD TUMOR

the pupils are equal and react to light; the eyegrounds are normal. Examination of the thoracic contents shows nothing of interest.

The second and third dorsal spines are tender to percussion.

Above the level of the second dorsal segment there are no sensory disturbances, but below it there are irregular areas where it is difficult for her to distinguish between heat and cold and where pain sense is dulled.

Touch is slightly if at all involved. The right lower extremity is from 0.5 to 0.75 of an inch smaller than the left, both above and below the knee. There is marked loss of power in both the flexor and extensor muscles, especially in the right lower extremity. There is marked fibrillary twitching of the thigh muscles.

Reflexes: Wrist and elbow increased. Patellar and tendo achillis greatly increased. Ankle clonus very marked on both sides. Babinski and Oppenheim reactions suggestive.

Ataxia, Romberg symptom, and disturbance of muscular sense in the hands absent. There is slight disturbance of muscular sense in the feet.

Spinal fluid, February 15, 1916: 15 c.c. removed. Pressure was slightly increased. Cells, all mononuclear, were 150 per cu. mm. Globulin ++. Albumin +. Sugar reaction prompt. Wassermann reaction negative.

Blood, February 16, 1916: Anisocytosis moderate. Poikilocytosis slight; white blood-cells, 300 counted; polymorphonuclears, 53 per cent.; transitionals, 1.5 per cent.; lymphocytes, 40 per cent.; large mononuclears, 3.5 per cent.; eosinophiles, 1 per cent.; mast cells, 1 per cent. Blood Wassermann negative.

Röntgen plates of the spine showed nothing of importance.

*Operation* (February 29, 1916).—Ether. Right hemilaminectomy was done involving the seventh costal and first, second and third dorsal spines. The bone was normal. The dura was slightly thickened. A tumor was felt through the dura, lying transversely over the dorsum of the cord at the level of the second dorsal. The first, second and third dorsal spines were clipped at their bases, pushed over to the left and the corresponding laminae on the left side removed.

The dura was split in the median line the whole length of the wound.

A small white firm tumor was attached to the dura just to the right of the incision in it. The tumor was removed with the dura at its base.

Another tumor, soft, vascular, dark reddish blue in color, lay to the right side and in front of the cord, apparently beneath the arachnoid. This extended from the lower edge of the first dorsal to the upper edge of the third dorsal and lay mostly in front of the cord, being especially large opposite the second dorsal spine.

eral times and the man left the hospital on November 20, 1914, with a healed wound. He had gained 15 pounds in weight.

The pathological diagnosis was carcinoma.

The man was readmitted to the hospital on March 2, 1915, with a fecal fistula, which had closed and reopened several times. Fluid movements came from the fistula, his bowels were loose and his appetite poor.

*Operation* (March 15, 1915).—Ileocolostomy for fecal fistula. The abdomen was opened through a left rectus incision. A loop of intestine was found adherent to the abdominal wall. A probe in the fistulous tract entered this loop, which consisted of the end of the ileum which had been turned in before the side-to-side anastomosis had been done. It was found impossible to separate this loop from the abdominal wall without entering into the site of the anastomosis. Accordingly the ileum was divided two inches proximal to the anastomosis with the cautery, and the distal end tied off with heavy silk, and the end inverted with two layers of linen sutures. The proximal end of the ileum was crushed with an angiotribe, tied off with linen and the stump inverted with three layers of sutures. A side-to-side anastomosis with linen sutures was done between the ileum, two inches proximal to the inverted end, and the descending colon, just below the splenic flexure. The omentum was then sewed over the area of the anastomosis as well as over the inverted end of the ileum and over the end of the ileum adjacent to the former anastomosis. The abdomen was closed with drainage. It was hoped that the old fistulous tract would gradually heal without extensive removal of the gut, which the man could not have stood at the time of this operation. In five weeks the fistula was closed and the patient left the hospital with both wounds healed. Since then there is occasionally a very slight discharge for a few days at the site of the old fistula. His general condition is very much improved and he has gained 33 pounds. He recently walked ten miles in one day. Two and a half years have elapsed since the first operation and there is no sign of any recurrence, in spite of the fact that enlarged glands were found in the mesocolon at the first operation.

#### REAMPUTATION OF FOOT BY THE METHOD OF PIROGOFF

DR. ELLSWORTH ELIOT, JR., presented a young man who was seen by him for the first time April, 1916, more than two years after an accident in which his foot had been crushed in a freight car collision and during which time he had been treated by various surgeons, first with amputation of the toes followed by amputation of the metatarsals, finally leaving a Chopart's stump. The anterior extremity of this

## CARCINOMA OF THE CÆCUM

present, quite different in appearance, one attached to the dura, and the second one separated from the first by the arachnoid but lying at the same level of the cord, and lying between the arachnoid and cord but not adherent to the cord.

*Pathological Report.*—The tumor attached to the dura is an endothelioma. The softer, subarachnoid tumor consisted of cells generally spindle or oval shaped, often taking a concentric arrangement about calcareous (psammoma) bodies of varying size. Some of the cells are more round, contain considerable protoplasm and thus resemble endothelial cells.

## CARCINOMA OF THE CÆCUM

DR. JOSEPH WIENER presented a man, fifty-one years of age, who was admitted to the First Surgical Service of Mt. Sinai Hospital August 14, 1914. His father had died at forty of pulmonary tuberculosis; his mother had died at sixty of cancer of the breast. One sister had been operated for cancer of the breast three years before.

At the age of ten he had had some intestinal infection, which had kept him in bed ten weeks with diarrhœa and bloody stools. He had married at twenty-one and had five children. After working for two years in a benzine factory he complained of loss of appetite and constipation. He came to this country in 1894, and had obstinate constipation since then. Seven months ago had influenza, and constipation had been more marked since then, necessitating use of purges. Four weeks before admission he noticed that he was losing weight rapidly, from 185 to 134 pounds. Two weeks later he noticed a mass in the abdomen.

Examination showed moderate emaciation, and in the right iliac fossa a hard, freely movable mass, somewhat tender, about two inches in diameter. Rectal examination was negative, but the stools contained a trace of blood.

*Operation* (August 17, 1914).—Resection of ileum and cæcum, and ileocolostomy for carcinoma of ascending colon. Abdomen opened through a right rectus incision. A hard tumor found in the cæcum about the size of a lemon. The cæcum was mobilized by dividing the outer layer of the mesocolon. The ileum was resected four inches from the cæcum and the ends inverted by three layers of linen sutures. The mesocolon was resected deep on account of the presence of enlarged glands. The colon was resected at the hepatic flexure, the end tied off with a linen ligature, reinforced by two layers of linen sutures. A side-to-side anastomosis was done with Connell sutures of linen. The abdomen was closed without drainage except for the skin. Time of operation fifty-seven minutes. A week later a small fecal fistula developed at the lower angle of the wound. This was cauterized sev-

there is no tendency for the heel to assume a position of hyperextension due to unantagonized contraction of the tendo achillis, so frequently seen after a Chopart's amputation or, in fact, after any amputation through the foot in which the ankle-joint is left intact where the flexor tendons are divided. This unfortunate sequel which renders the stump practically useless as a means of support may frequently be avoided, as in this instance, by the suture of the divided ends of the flexor tendons to the anterior extremity of the dorsal surface of the remaining tarsus, thus providing a new point of attachment.

A question worthy of discussion apart from the question of the flap is the relative value, from a functional standpoint, of a stump of this character with a special boot and such a stump as may be secured by a supramalleolar amputation with an artificial leg. He was inclined to believe that the present stump will prove more satisfactory.

### CONGENITAL TORTICOLLIS

DR. ROYAL WHITMAN presented a patient fifteen years of age, illustrating the operative treatment of congenital torticollis. The points to which he called attention were the complete division of the contracted muscles and fascia to permit overcorrection of the deformity, and the necessity for after-care by manual stretching and exercises. By drawing the skin upward at the time of operation the scar was eventually below the clavicle, a point of importance in the treatment of girls.

DR. FRANK S. MATHEWS said that up to about three years ago in doing torticollis, he used to put the head and upper part of the chest in plaster. Since then, in eight or ten cases, he had simply divided the skin and all contracting tissue, applying a simple dressing and letting the child put the head in any position it wanted, which, of course, would be the original one, until the wound was healed. After that he began the correction. If overcorrection is tried at once, it tends to pull the wound apart. It seemed to him there was an advantage in letting the skin wound heal firmly and then beginning the correction of deformity, in say eight or ten days.

DR. WHITMAN, in reply to Dr. Mathews, said that he supplemented complete division of the contracted tissues by a vigorous stretching, and if the patient was a child, fixed the head for several weeks in an overcorrected attitude by a plaster support. The aim was to overcome what might be called the deformity habit both in the patient and in the structure of the neck. He thought wide separation of the divided tissues of great advantage and had seen no ill effects from it.

## REAMPUTATION OF FOOT BY PIROGOFF METHOD

stump presented a granulating area the size of a half dollar over the cuboid bone, with extensive cicatricial tissue extending backward on both the inner and outer aspects in which were several smaller areas of ulceration the size of a pea. The sides and plantar surface of the heel were covered with normal skin in sufficient quantity to provide adequate flap material for a Syme's but not for a Pirogoff's amputation. Several unsuccessful attempts at skin-grafting had been made, the patient having been anæsthetized eight different times.

Notwithstanding probable failure, it seemed worth while to make the attempt to secure healing of the stump by the removal of the cuboid and scaphoid. The subsequent sloughing of the cicatricial tissue, which formed in part the flap material, left an ulcer of practically the same size and position as existed prior to the operation. Three different procedures were then considered; a Syme's amputation, a supramalleolar amputation and some form of plastic operation for covering the denuded stump, leaving its length intact. Three or four very satisfactory results after Pirogoff's amputation led to the selection of the last named procedure. After etherization a pedunculated flap was dissected from the opposite calf and carefully approximated by suture to the ulcerated area of which the edges and surface had been freshened. The legs were then immobilized by plaster of Paris applied to both knee-joints and to the non-affected ankle. The distance between the legs was kept constant by the incorporation in the plaster of basswood splints both in front and behind the knee-joints and, similarly, by longer splints extending from the knee of the stump side to the opposite ankle. Of these two latter splints, the posterior served as a support for the heel of the stump side, which, through flexion of the knee-joint above, was placed in close contiguity with the calf just below the point of the attachment of the pedicle of the flap. Immobilization was continued for four weeks when the pedicle was divided in two stages separated by an interval of four days. It is interesting to note that during this time the patient experienced no discomfort and that all joint stiffness had disappeared within a week after the immobilizing apparatus was removed. The rather prolonged time of immobilization before the division of the pedicle of the flap seemed to be indicated by the fact that the tissue to which the flap was to be applied was, even under normal conditions, sparsely supplied with blood and that its complete vitalization would require a correspondingly long interval. A small ulcer at the point of junction of the flap and tissue of the heel which healed very slowly seemed to justify this conclusion.

It is interesting to note the excellent flexion and extension of the ankle, of which the patient is capable. This is practically normal and



Moynihan reported a series of similar cases and discussed the condition in full in the February number of the *ANNALS OF SURGERY* in 1907. He writes, "Whereas in usual 'acute' perforations of the duodenum the rupture is of fair size and at once allows the contents of the gut to spread themselves freely over the general peritoneal cavity and to cause there a universal infection, in subacute perforation there is, by one agency or another, a definite localization of the fluids escaping from the duodenum and, in many instances, a narrow circumscription of the peritoneal response to their invasion."

This localization he points out may be due to a very small perforation, an empty stomach at the time of perforation, or the plugging of the opening by omentum.

In the November number of the *American Journal of Röntgenology*, there is an abstract from the *Munch. med. Wochensch.* of August 29, 1916, p. 1278. Robert Lenk, who was on the Isonzo Section of the Eastern front, calls attention to the appearance of gas bubbles between the right diaphragm and the liver in the shape of a light, narrow semilunar strip above the hepatic border in certain cases of bullet perforation of the gastro-intestinal tract. He suggests that in times of peace this sign will be found of value in differentiating between perforated gastric ulcer and acute appendicitis or cholecystitis.

The X-ray plates in this case show distinctly this narrow semilunar strip of lessened density above the right lobe of the liver (see Fig. 7). Doctor Martin said he believed this observation of Dr. LeWald to be of real value in differential diagnosis.

#### THE LIMITATIONS OF RADIUM IN SURGERY

DR. EDWARD M. FOOTE read a paper with the above title, at the close of which he presented a man, stating that some eleven years ago he had a sore on the right side of his lower lip. About ten years ago it was removed by excision of a small piece of the lip, the wound being sutured. Some time after that he had a local recurrence. This was variously treated by caustics and X-ray, and in 1913 he came under Dr. Abbe's care, who treated him by the application of radium in periods of two hours each, causing a temporary disappearance of the tumor. Then Dr. Abbe went to Europe in 1913, and the patient for the first time came under Dr. Foote's observation. At that time he had a scar from his previous operation and caustics, with enlarged glands beneath the jaw on both sides.

An incision was made through the lip extending under the jaw, both to the left and right, and the glands and surrounding tissues, including

## SUBACUTE DUODENAL PERFORATION

### SUBACUTE DUODENAL PERFORATION

DR. WALTON MARTIN presented a man twenty-six years old, who was admitted to the medical service of St. Luke's Hospital on October 31, 1916. The day before admission, at nine o'clock in the morning, while drinking a cup of coffee he was seized with agonizing pain in the abdomen. He vomited several times, the vomitus did not contain blood. A doctor was sent for and gave him morphine. In the evening he was again in great pain and developed a slight cough; he saw the same physician, who sent him to the hospital with the diagnosis of pneumonia.

He had been in good health before this attack excepting for slight indigestion. Two and a half years ago he had a similar attack of severe abdominal pain and vomiting. This attack had lasted three days. He thought the pain at that time had been in the right lower quadrant of the abdomen.

On admission his temperature was  $102.8^{\circ}$ , his pulse 118, and his respiration 28. The leucocyte count showed 18,000 white cells with 70 per cent. polymorphonuclears. The patient looked sick. There was slight dulness over the right lower lobe posteriorly. The abdomen was not distended. There was no rigidity. There was acute tenderness on palpation over the upper right side of the abdomen.

The X-ray examination showed an area of lessened density above the shadow of the liver and below the outline shadow of the diaphragm. The X-ray operator, Dr. LeWald, ventured the suggestion that there was free gas in the peritoneal cavity.

Dr. Martin had advised an immediate operation. The medical attendant refused, however, to give his consent. The patient did not improve, the fever continued, the pain persisted and gradually a large mass became palpable in the right lumbar region, apparently in front of the kidney. He was finally transferred to the surgical division and eleven days after the onset an abscess was opened and drained through the upper margin of the right rectus. The pus which was evacuated had a foul odor. An X-ray examination taken the next day showed the cæcum in a normal position. It also showed a deformity of the duodenal cap.

The edge of the wound became irritated by the discharge from the abscess, suggesting a perforation of the upper intestinal tract. The patient made a good recovery, and since his illness has been free from the indigestion which he has had for many years.

Dr. Martin said he had shown the case on account of the difficulty in diagnosis and on account of the unusual interest of the X-ray findings. He believed the case to have been one of subacute perforation.





FIG. 7.—Case of subacute perforation of the duodenum, showing narrow semilunar strip of lessened density above the right lobe of the liver (see arrows).

The former are often seen in variously arranged bundles separated by well-defined fibrous septa. In some places the smooth muscle arrangement resembles much the make-up seen in ovarian stroma. The epithelial elements that are present are arranged forming cyst walls. Some are low cuboidal in type and disposed in a singular layer about irregular cavities containing hemorrhagic material and a variable degree of débris. Others have an adenomatous arrangement and are high columnar, resembling the cells which normally are found in the glands of the uterine mucosa. There is a frequent focal collection of round-cells and in one situation are most peculiarly arranged groups of spindle- and round-cells with wide epithelial spaces which have probably been filled with cholesterin crystals.

*Microscopic Diagnosis.*—Adenomyoma of round ligaments.

December 15, 1916: Discharge note: Scar holding firmly. No bulging or impulse on coughing or standing. No pain. Feels fine. Discharged cured. Highest post-operative temperature 101°.

#### RUPTURE OF LIVER

DR. H. B. DELATOUR presented a boy, aged ten, who was admitted to St. John's Hospital, Brooklyn, February 24, 1916. Two days before admission while coasting he was thrown from his sled, striking the stump of a tree. Shortly after he was seen by his family physician who made a diagnosis of internal hemorrhage. He was in deep shock with very rapid and feeble pulse. He slowly improved. He continued to have severe abdominal pain. On admission temperature was 100.6° F., pulse 102, and respirations 24. The patient complained of abdominal pain with no point of tenderness. Examination showed moderate distention and dulness in both flanks without marked tenderness. The general condition was fair. The following day the condition remained the same, temperature at 8 P.M. was 100° F., pulse 82, and respiration 26. During the day patient had vomited some medication and curdled milk.

*Operation.*—Upper abdominal median incision. On opening, two quarts of blood escaped. There was no evidence of recent bleeding, the cavity was sponged dry and on the under surface of the right lobe of the liver was found a tear four inches long. As there was no bleeding this was not sutured. Abdomen closed without drainage. Recovery was uneventful.

Dr. Delatour presented also a boy, aged six years, who was admitted to the Norwegian Hospital October 22, 1913, having been run over by a delivery wagon about fifteen minutes before. Examination showed the wheel had passed across the lower right chest and upper abdomen. The patient was in severe shock, lips pale, pulse rapid and weak and there was evident active intra-abdominal bleeding. The abdominal

skin, were removed and the wound was sutured. Not quite a year afterwards he again had a small recurrence, this time in the lip only. It was cut out without the neck being disturbed. The lip was restored, a certain amount of flap being obtained from the cheek. This was in January, 1914.

It is now three years since that time and there has been no further recurrence.

*Stated Meeting, held January 24, 1917*

The President, DR. CHARLES N. DOWD, in the chair

### BILATERAL DIRECT INGUINAL HERNIÆ WITH BILATERAL ADENOMYOMA OF ROUND LIGAMENTS

DR. FREDERICK T. VAN BEUREN presented a woman, thirty-four years of age, who was admitted to Roosevelt Hospital, November 20, 1916, on account of pain in the groins and pelvis, and an irreducible mass in each inguinal region.

*Operation* (November 27, 1916).—Right side incised down to cystic tumor which lay outside of the external oblique. It was freed from surrounding structures, ring identified, and external oblique aponeurosis split upward, exposing internal oblique and hernial sac which was about 3 inches long and  $\frac{1}{2}$  inch wide, thickened and very adherent to the surrounding tissues. Sac of hernia dissected free, sac opened, found not to communicate with cystic tumor, neck explored into the peritoneal cavity, neck transfixed, ligated, amputated and stump dropped back. Internal oblique brought down to Poupart's ligament with four interrupted chromic sutures; the upper two sutures passing through the round ligament, anchoring it in place. Aponeurosis of the external oblique united by plain continuous catgut, the skin by silkworm gut and silk. Dry dressing and binder applied. The left side was treated in a similar manner. The tumors were removed with distal end of hernial sac and round ligament.

*Report of Pathologist.*—The specimen consists of two irregular globular masses of dark blue colored tissue, measuring  $3\frac{1}{2}$  to  $4\frac{1}{2}$  cm., covered by fibrous adhesions, presenting numerous crypts and indentations. Several small, thin-walled cystic bodies are seen on the surface. A small cylindrical tab, the size of a vermiform appendix, is attached to one side; the interior shows a dense, light colored stroma, in which appear numerous large and small cysts, some containing a hemorrhagic, and others a mucoid fluid. In the gross the specimen presents much the appearance of tissue from a cystic ovary. Three sections for microscopic examination.

*Microscopic Examination.*—The mass of the sections seen are made up of a stroma of smooth muscle and fibrous tissue arranged in an atypical manner.

He came under the care of Dr. Delatour in the latter part of September, and on September 30 a complete excision of the rectum and lower sigmoid was done by the combined method, with the production of an abdominal anus. During the perineal stage, while making strong traction during the separation from the prostate, the urethra was torn free of the gland. To remedy this a method was used which had been found useful in two similar cases, the result of accidental injury. A catheter was passed through the urethra into the perineal wound and then passed into the bladder. It was then sewn by two chromic sutures to the anterior edge of the prostate. Traction was then made on the catheter until it brought the divided ends of the urethra together. A safety pin passed through the catheter at the meatus kept up this elastic pressure. The catheter was removed at the end of a week and sounds passed. The union was perfect and they never had any trouble from urinary leakage.

The abdominal wound healed very slowly, owing to dry gangrene of the rectus muscle. No adequate reason for this could be found. There was no apparent sepsis, and the blood supply was not interfered with. The man was very weak and much reduced and traction on the blood supply during operation may have been responsible. As a result of this the wound healed by granulation, leaving a hernia to be repaired later. He is wearing the colostomy apparatus designed some years ago by the reporter and he is perfectly confident of not soiling himself while going about.

Dr. Delatour said that formerly he did a two-stage operation, but now in most cases he was better satisfied with a completion of the operation in one stage. After making the abdominal incision and incising the peritoneum at the level of the reflection of the bladder and exposing the ureters, the dissection is carried down in front to the prostate and posteriorly to the coccyx. The bowel is then severed at the level desired, both ends of the bowel are tightly closed, the upper end placed in the desired position for the anus and the lower section tucked into the pelvis. When there is more bowel than will comfortably go into the pelvis a section is removed. The peritoneum at the brim of the pelvis must now be carefully closed over this mass. After closing the abdominal wall one may or may not proceed with the removal of the distal segment. The second step consists of an incision about the anus carried back to the coccyx, no bone is removed, and then the dissection carried up until the bowel is freed and removed. As this stage takes only from eight to fifteen minutes and is not attended by hemorrhage, most patients can well stand it.

## CANCER OF THE RECTUM

wall was rigid, there was tenderness in the right hypochondriac region and marked dulness in both flanks. There was a marked tenderness over the right kidney.

*Operation* (on day of admission).—Median upper abdominal incision. On opening the abdomen there was an escape of fluid blood. In the under surface of the right lobe of the liver was a tear about two inches long. Pressure with a sponge soon checked this and the edges were brought together by a catgut suture. During the examination a large hæmatoma was found post-peritoneal about the right kidney. Abdomen closed without drainage. The temperature ran between  $99^{\circ}$  and  $101^{\circ}$  until the fourth day, when there was a sudden rise to  $104^{\circ}$ . The temperature remained between  $102^{\circ}$  and  $105^{\circ}$  for forty-eight hours when it suddenly dropped to normal. There was a slight rise during the next two days, but the third day the temperature reached  $105^{\circ}$ . The pulse was 160, respirations averaged from 48 to 56. Dulness persisted over the right chest. Resection of the ninth rib was done, the pleural cavity opened and considerable blood-stained fluid evacuated. Notwithstanding this, the temperature continued to fluctuate between  $102^{\circ}$  and  $104^{\circ}$ . A few days later a mass could be made out in the neighborhood of the right kidney. An incision in the right lumbar region evacuated a quantity of pus; the kidney was not involved. Drainage was established. The temperature gradually fell following this operation, reaching the normal about two weeks later. The patient was discharged from the hospital March 7, 1914.

In both these cases the force of the blow was delivered from in front with the tear on the under surface of the liver. This is evidently due to the bending of the organ and the giving way of the capsule when it can no longer stretch. It has been his experience to find the tears generally in this position. It is worthy of note the ease with which hemorrhage may be checked by pressure even in quite extensive and deep tears of the liver.

## CANCER OF THE RECTUM

DR. DELATOUR presented three cases which were operated within ten days of each other, and each shows a different way in which the case was treated before coming to operation.

The first was a case of carcinoma low down in the rectum, which had been going about for over a year complaining of intestinal symptoms and hemorrhoids. He had been given a superficial examination for hemorrhoids twice and nothing was discovered. Later a rectal examination had been made and a diagnosis of possible syphilitic ulceration was made and he was given salvarsan treatment, without benefit.



day, although there is no doubt that the sphincter cannot have its normal impulse of contraction because with the removal of the lower end of the rectum the terminal fibres which would stimulate the sphincter to contract must have been divided.

DR. DELATOUR rejoined that in three cases in which he made a perineal implantation there was complete lack of control and the patients were certainly very much more uncomfortable than with an abdominal anus. It is much easier to take care of the abdominal anus than it is a perineal anus if there is lack of control.

He had had three cases operated by the combined method in which he did a two-stage operation. Two of these cases did not react well during the next day or two and he did not feel like giving them an anæsthetic again and the intestine that was left in the pelvis set up sepsis which gave considerable anxiety.

In one case he did the second stage of the operation on the fifth day, under hyoscine and morphine, and the patient made a good recovery, but he was very much worried during the whole time he was waiting to get her in condition to do something for fear of general sepsis developing.

As he does the operation now, so much is done from above that the second stage of the operation is very short; the incision is carried back to the coccyx and there is no bone removed. Bleeding is practically all controlled from above before you make your incision below.

He preferred the median position of the anus, going through the fibres of the rectus muscle to the lateral, because his apparatus can be more easily fitted in that position.

He had a record of one case eight years, one seven years, another four and another two by this method without any recurrence. The man who is six years is a captain on a steamer and is going to sea regularly. He believed that where one removes a large section of the bowel and thoroughly cleans out all the fatty material in the hollow of the sacrum where the glands are, one has an excellent chance for a permanent cure.

He had had eight successive cases now without death.

DR. CHARLES N. DOWD, in discussing these cases of excision of the rectum for carcinoma, called attention to the vigor and strength of the patients. The one-stage combined operation is a severe procedure, but when one is to deal with strong men of middle age such as these patients are, one may do a very much more severe operation in one stage than would be practicable for less vigorous patients. The two-stage operation in which the upper part of the distal intestinal segment

## CANCER OF THE RECTUM

The second was a man fifty-six years old who for a year and a half had been suffering with abdominal pain and had had one attack of partial obstruction which was relieved after lasting for twenty-four hours. On April 27, 1916, he had another attack of obstruction which was complete and lasted for four days before he was operated.

At that time there was a great deal of distention and the operator did not think it wise to do a radical operation. He discovered a mass in the upper end of the rectum and simply made a colostomy.

The patient made a good recovery, but after a few days the fecal contents began to pass beyond the colostomy and out through the rectum and he began to suffer a great deal of disturbance. The colostomy opening narrowed down and did not give the desired relief. When he came to the reporter he had lost a good deal of weight and was suffering from the inconveniences of an anus which would discharge only a portion of the fecal contents, so that occasionally he would have a movement by the rectum. He was operated upon in the manner described on October 9 last. He has the same apparatus and he is going about his business now perfectly happy. He has developed regular periods for moving the bowel and at other times has very little drainage. The perineal wounds give no trouble.

This apparatus looks rather large and cumbersome, but still the patient does not complain and it hardly shows at all in the clothing.

A third case was in a man forty-eight years of age, who, for about a year, had been having rectal symptoms when a carcinoma was discovered in the lower third of the rectum. A similar operation was done.

These men wash out the bowel once or twice a week, maybe once a week, taking a cathartic, and go about with perfect comfort and feeling of security.

DR. FRANZ TOREK said that he had recently done a one-stage operation for carcinoma of the rectum. In this case he did a complete amputation of the lower end of the rectum by the one-stage operation, that is, first median incision, loosening everything, as has been described, down to the pelvic floor—to the levator ani—and then operating from below by resection of the coccyx and bringing down the tumor end and loosened portion of the bowel to the anus.

He said that he was very well pleased with it. In the first place, there is only one opening, the natural opening, and in the second place, one thing that he feared—that there would be a constant leakage of the feces from the anus—did not occur.

At the present time this woman has a movement only every second

plaster were then applied transversely across the grafted area, and a roller of gauze was placed outside of them. These straps were left in position for six days, after which they were carefully removed.

At that time, about seven-eighths of the area was covered by grafts or by visible epithelial pellicle, and about one-half of the remainder

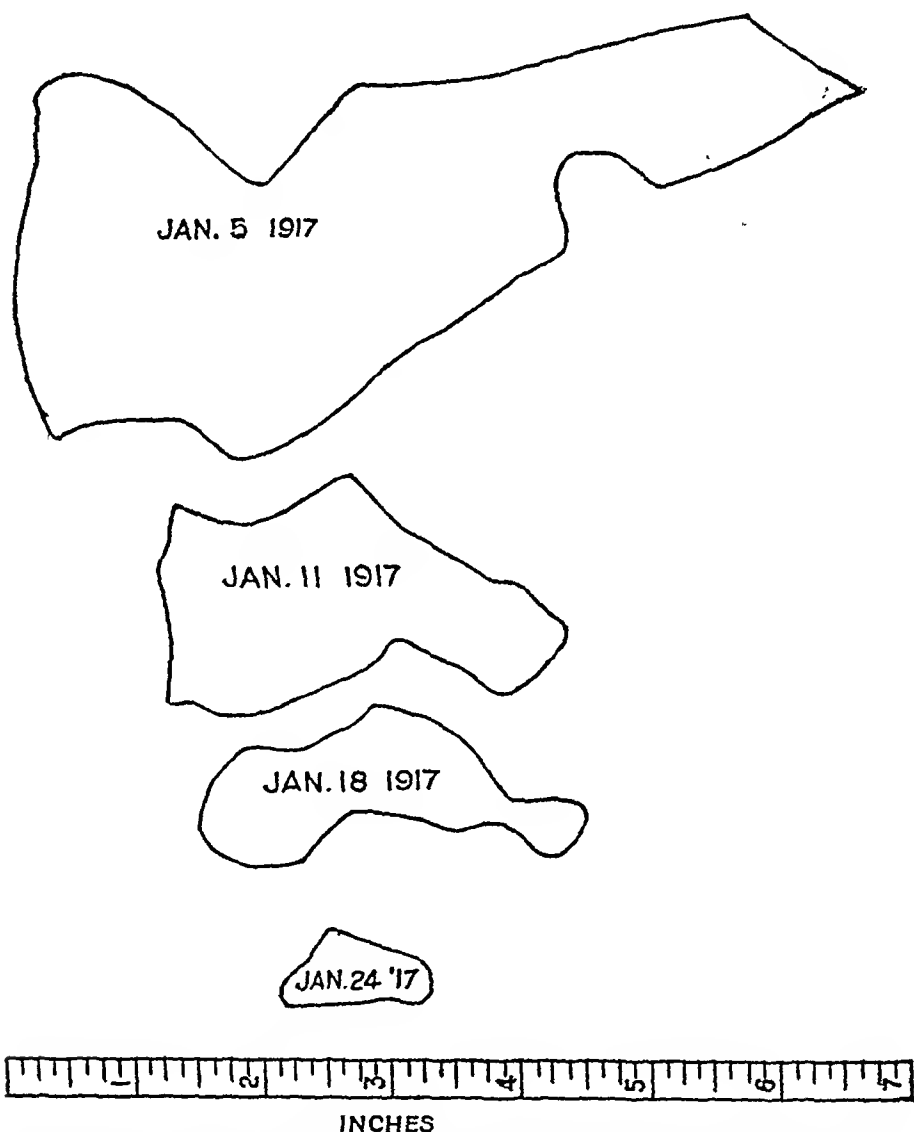


FIG. 9.—Treatment of burn by paraffin mixture. Progressive diminution in size of granulating area shown by the cutting of rubber tissue models at intervals of six and seven days.

looked as though a very slight epithelial pellicle might be present. Another similar dressing was then applied and left in position for five days. On its removal the grafts seemed much firmer, and the epithelial pellicle which existed where the superficial grafts had come away was more definite.

## TREATMENT OF BURN BY PARAFFIN MIXTURE

is left as a pouch, as advocated by Mayo, gives a method of securing a very thorough operation with less danger than the one-stage operation necessitates.

### TREATMENT OF BURN BY PARAFFIN MIXTURE, AND BY SKIN GRAFTS WITH DRESSING OF ADHESIVE PLASTER (VOSBURGH METHOD)

DR. CHARLES N. DOWD presented patients illustrating the two methods which had been considered at the November 22 meeting of the Society (ANNALS OF SURGERY, lxxv, 370). Soon after that meeting he had used a paraffin mixture for two cases of extensive burn then in the wards of the Roosevelt Hospital. The mixture used was prepared by the house surgeon, Dr. Raymond H. Schulz, and was composed of paraffin, two parts, vaseline, two parts, and stearic acid, one part. It melted at 112° F., and could then be easily applied to the burned surface by cotton pledgets held in dressing forceps, the resulting film making a protective dressing which was further guarded by gauze. The dressings were changed every second day.

One of the cases improved very satisfactorily. In the other, the granulations quickly became exuberant, and skin grafting was resorted to.

The difference in the two cases seemed due to the depth of the burns. Islands appeared in the surface of the first case, which indicated that the skin destruction had not been complete, although it had appeared so. Epithelium ran out from these islands very rapidly under the paraffin film. (The appearance is well shown in Fig. 8, and the rapid rate of growth is shown in the accompanying diagram, Fig. 9.)

The patient had been under various forms of treatment for about ten weeks before the paraffin treatment had begun, and had recovered from the constitutional depression, which had been very great at first. The result of the paraffin treatment was remarkably satisfactory.

The second case, a child of five years, had been treated for twenty-nine days for a severe burn, involving the posterior portions of thigh and leg, with warm air, wet dressing, and rubber tissue with splint. On December 4, paraffin dressing was applied. On December 14, the areas were strapped transversely with zinc oxide adhesive plaster because the granulations had become so exuberant under the paraffin treatment; these straps were applied very firmly for eight days when the granulation had become smooth and almost flat. Thiersch skin grafts were then removed from the anterior and outer surface of the right thigh and were applied to this granulating surface after it had been washed with saline solution. Straps of zinc oxide adhesive



FIG. 8.

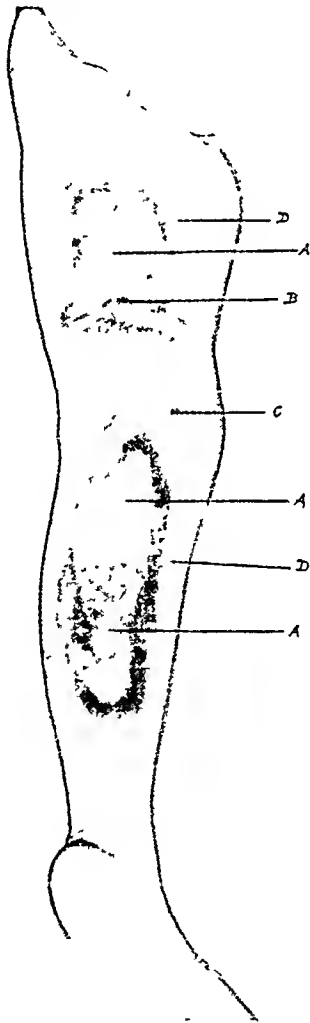
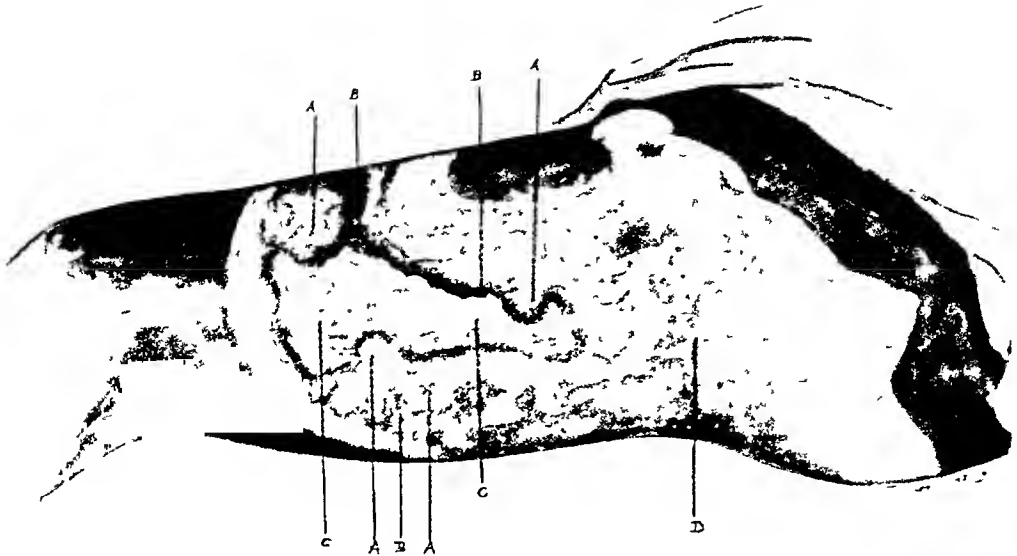


FIG. 10.

FIG. 8.—Appearance of burned thigh, four weeks after paraffin treatment was begun. *A*, islands from which epithelium extended; *B*, newly-formed epithelial pellicle; *C*, granulating surface; *D*, newly-formed skin in the more superficial parts of the burn.

FIG. 10.—Burn treated by skin grafts held in position by adhesive plaster (Vosburgh method). Sketch made fifteen days after the application of the grafts. *AAA*, grafts which had united over the entire surface excepting at the small spots *B*; *B*, small spots where the plaster had rubbed the grafts and prevented union; *C*, small granulating area which had not been grafted; *DD*, margin of burn where the skin had thickened before the grafts were applied.

was in considerable shock, yet ambrine put on at a temperature of 130° caused a great deal of pain. Only one application was made, as she died in twelve hours.

The next case was a girl of ten with first degree burns of the buttock and thighs. They had a great deal of difficulty in putting the ambrine on, as she complained so much of the pain; they had to drip it on with the brush, instead of applying it lightly with a brush as with the other cases. After two dressings it was given up because she complained so bitterly of the pain.

The last case was one of the attending surgeons who scalded his arm in the operating room. Ambrine was applied to the arm at a temperature of 150° F. which he decided was too high, but it relieved him from pain immediately, and the burn healed without forming blebs.

He felt that enough cases had not yet been treated with ambrine to really pass judgment, but was inclined to believe that the advantage of ambrine had been rather exaggerated.

DR. SETH M. MILLIKEN said that the open-air treatment of burns brought out the point mentioned as to islands of epithelium in the raw area very plainly. Where there is no dressing applied and the granulations have been for some time in a fairly flat condition, the islands in many cases were very rapidly developed, although the burn extended apparently clear down to the fat and apparently at the time of separation the entire skin had sloughed off.

In the Bellevue Dispensary he had a burn discharged from the ward under a boric acid dressing which on admission involved the entire right half of the chest. At the time he was discharged from ward it involved one-third of the side of the chest—that is, a little more than the entire axillary region. Under boric acid dressing it was tender and entirely raw. That was strapped with adhesive, and he came back saying he had been free from pain under the strapping. On removing it there were many areas of epithelium evident and the edges had grown in in two days at least half a centimetre. He healed up in twenty-seven days, with dispensary treatment, and he had been in the ward some five weeks before discharge. As soon as the epithelium had covered the area, instead of using an oily dressing, the wound was very thickly powdered with stearate of zinc, which protected the surface so that there was no pain in moving the dressing.

DR. WIENER said that in the last eight years he had not put any dressing on any skin graft. It is perfectly astonishing, not only how often the grafts take, but how quickly. In forty-eight hours the grafts

## TREATMENT OF BURN BY PARAFFIN MIXTURE

A paraffin mixture was then applied over the grafts, and gauze outside of this. (Fig. 10 indicates the appearance of the leg four days later. The grafts had all taken excepting a very small area where the motion of the leg had caused rubbing from the adhesive plaster.) At a later time, a little pus collected under some of the grafts, and consequent delay in the final healing was thus caused. This accident could probably have been avoided by removing the granulations before applying the grafts, according to the method in ordinary use.

The paraffin mixture was applied to the area on the right thigh from which the grafts were cut, and the healing of this area was very satisfactory, much better than in any case which the writer had seen when treated by other methods.

DR. RANSOM S. HOOKER said that on the First Surgical Division of Bellevue Hospital there had been treated several cases of burns with ambrine. The first case was a man with first degree burns of the face and both hands. On the third day after admission the ambrine treatment was started; before which he had been treated with hot air. Ambrine was applied to his face and one hand, using the other hand for comparison, although the hand treated by ambrine was much more extensively burned than the other.

The paste could not be applied as advocated,  $140^{\circ}$  to  $150^{\circ}$  F., for the man complained so much a heat of only about  $130^{\circ}$  or  $135^{\circ}$  could be used. The hand healed up very well in eleven days, about the same time as the other hand which was treated with dry air and alkaline baths. He doubted if the face healed any faster than is usual with routine treatment.

The next case was a woman, who was admitted on September 13 with very extensive burns of the back, buttocks, both thighs posteriorly and the right arm and hand. She had been treated by hot air and by alkaline baths. On the sixth of December she had healthy granulating areas over these parts. Ambrine was applied to the right arm and hand and to the left leg. The left leg was chosen as being possibly a little worse than the right, although there was very little difference, but the right was kept as a control. On December 19 the ambrine leg had improved very much over the leg treated by hot air, so Dr. Vosburgh strapped the right leg; on January 5 the right leg was healed, whereas the ambrine leg was only two-thirds healed, so it was decided to abandon the ambrine and strap the arm and both legs, which were all healed by January 15.

Another case was a very severe burn in a girl four years old. The back, abdomen and legs were burned, first and second degree. She



64 per cent.; macrocytes and normoblasts to 120 whites counted; lymphocytes, 23 per cent.; endo., 6 per cent.; transitionals, 2 per cent.; eosinophiles, 4 per cent.

November 20, 1916: Hæmoglobin, 33 per cent. Sahli; red blood-cells, 3,072,000; Ck., 53; white blood-cells, 8,800; polymorphonuclears, 71 per cent.; lymphocytes, 21 per cent.; leucocytes and transitionals, 1 per cent.; transitionals, 5 per cent., no abnormal cells; eosinophiles, 2 per cent.; normoblasts, 3.

November 27, 1916: Hæmoglobin, 34 per cent.; red blood-cells, 3,176,000; C. I., .54; white blood-cells, 10,200; polymorphonuclears, 77 per cent.; lymphocytes, 21 per cent.; L. M., 3 per cent.; transitionals, 8 per cent.; eosinophiles, 1 per cent.; normoblasts, 1; myeloblasts, 0.

His temperature ran frequently to 103° or 104°. The periods of elevation and remission of temperature were irregular.

Open air and other methods of treatment were used for about five weeks without improvement. Splenectomy was then advised as a desperate chance and he was transferred to the First Surgical Division of the Hospital for that purpose. The operation was done December 9, 1916. The spleen was adherent to the surrounding structures, but the adhesions were separated without particular difficulty; it was removed after ligation of its pedicle. There were 3 or 4 lymph-nodes at its hilum fairly firm and about ½ inch in diameter. No other enlarged lymph-nodes were found.

The pathological report from the spleen and lymph-nodes was as follows:

*Gross.*—Tumor is 20 cm. by 13 cm. by 7 cm. It is light purple and is covered with an unorganized layer of fibrin. The organ contains numerous nodules of alternate loose and dense structure which look whitish and a little caseous. Lymph-nodes enlarged but show no other gross abnormality.

*Microscopic.*—Sections show areas of necrosis with infiltration of many polynuclear cells. Normal architecture of spleen has disappeared and has been replaced by groups of lymphoid cells with intervening, moderately loose reticular tissue containing few cells. The lymph-cells show no unusual features, but in addition there are many "Dorothy Reed" cells throughout. Eosinophiles are present in places. No definite Malpighian corpuscles are seen in entire section. Lymph-nodes show no abnormality except "Reed" cells which are seen in moderate numbers.

*Microscopic Diagnosis.*—Hodgkin's disease of spleen and mesenteric lymph-nodes.

The boy has improved steadily though slowly since his operation and now is out of bed and sitting in a chair in the ward a part of each day. His blood did not show much improvement until January 22, when transfusion of 300 c.c. of blood was made. His red corpuscles are now 3,200,000 and his hæmoglobin 65 per cent. He is gaining in strength, but recently has shown slight ascites again. Urine examination has remained negative.

## SPLENECTOMY FOR HODGKIN'S DISEASE

have taken if one puts no dressing on whatever. Not only do they take, but they stay taken, in children and adults and in all parts of the body.

The patient is put in the proper position and the grafts exposed to the air. One can see the next morning already that the grafts have taken. A few of the men who have tried it have made the mistake of putting on a vaseline dressing after a week. Even that should not be done, not even vaseline should be put on these grafts for ten or twelve days. He had not had a single real failure in eight years—no matter how big the grafts were or where they were, no dressing was applied. The granulations must be carefully prepared either by scraping with a sharp spoon or by cutting them down with knife or scissors. It depends on the individual case as to what preparation the granulations need, but once the grafts are on nothing is put on the graft, not even vaseline for twelve days. If that is done, about a hundred per cent. will take.

## SPLENECTOMY FOR THE SPLENIC FORM OF HODGKIN'S DISEASE

DR. CHARLES N. DOWD remarked that in writing of the splenomegalic form of Hodgkin's disease Osler states that "it is not improbable that the disease may originate in the lymphoid tissue of the spleen and several cases have been reported of late years by Ziegler, Symmers, Warrington and others. It must be very difficult to distinguish such cases clinically from the early stages of Banti's disease." Such cases are surely uncommon. The palpable lymphatics usually give the most noticeable lesion in Hodgkin's disease.

He presented a boy of eight years who he believed to be one of the exceptional cases. An enlarged spleen was first noticed last summer while recovering from diphtheria in the Willard Parker Hospital. He came under Dr. R. G. Freeman's care at the Roosevelt Hospital in November, showing an enlarged abdomen with ascites, a very large spleen, a large liver and extreme anæmia. There were no other noticeable lesions. The spleen extended  $5\frac{1}{2}$  inches below the costal margin in the left nipple line and 3 inches below it in the axillary line. It was hard and the notch was easily felt. The liver edge was felt 2 inches below the right costal margin.

Chest examination, urine examination, Wassermann test, von Pirquet test and bacterial culture from throat were all negative.

The results of three blood examinations were as follows:

October 31, 1916: Red blood-cells, 1,380,000; hæmoglobin, 40 per cent.; white blood-cells, 12,200; red cells many; polymorphonuclears,





FIG. 11.—Carcinoma of the thyroid.

The patient was referred to Dr. Corscaden for X-ray treatment, which was begun September 15, 1914. The dosage was as follows: Spark gap, 22 cm. anode; skin distance, 25 cm.; filter, 3 mm. aluminum, 1 cm. of wood. The neck was divided into three areas and through these were given from September 15, 1914, to December 30, 1915, 1000 milliamperè minutes, in three sessions, about four months apart. After each application the skin became erythematous. Permanent change in the skin has been a slight tanning. The patient was put on thyroid tablets for trial, but these had to be discontinued because of rapid heart action and general discomfort. Now, two and a half years after the operation, the patient is perfectly well. There are no symptoms of myxœdema. She feels perfectly well. There are no evidences of any recurrence of the tumor locally. There are no enlarged cervical glands nor distant metastases. Röntgenogram of the chest shows it to be clear, with no evidences of any growth in the lungs.

DR. JOHN ROGERS remarked that carcinoma of the thyroid is one of the rarer forms of malignant disease. This is fortunate, because very seldom is the diagnosis made in time to place the case in the operable class. A good many of the carcinomata of the thyroid show hyperthyroid symptoms, and it is quite easy to mistake the condition for one of exophthalmic goitre.

The interesting point about this case is the absence of the thyroid and the absence of symptoms. The patient seems to be in perfectly good condition, and yet Dr. McWilliams is sure that he has left no thyroid gland. Dr. Rogers had seen a good many bad results from thyroid operations, but he did not remember ever having encountered a case of true cachexia strumipriva. The text-book's description of the severe and fatal post-operative myxœdema has not occurred in his experience, and yet he had observed at least a dozen cases of thyroid disease in which the operator believed that he had entirely removed the thyroid gland. Cases operated for symptoms of hyperthyroidism are somewhat different. If the operation is not successful, the symptoms of hyperthyroidism continue, with some modification perhaps from the original form, but without manifest myxœdema. There are one, or possibly two, explanations for this. It is not impossible in the first place that the thyroid secretes during any given moment an extraordinarily small amount of fluid, and if any portion of the gland remains the extraordinarily small amount of material which the thyroid produces may still be produced by the remaining portion of the gland.

A number of years ago he dissected about sixty cadavers, and ex-

## CARCINOMA OF THYROID

### CARCINOMA OF THYROID

DR. CLARENCE A. MCWILLIAMS presented a girl, eighteen years of age, who was admitted to the Presbyterian Hospital on August 27, 1914. Three years previously she had noticed that her neck was growing larger. It has grown steadily larger since then. No evidences of Graves's disease, *i.e.*, she is not nervous, no tremors, no sweating, eyes never prominent, skin not dry, no diarrhoea, no palpation, no dyspnoea, has lost no weight, pulse normal. Examination showed a single goitre, 5 by 10 by 5 cm., occupying the midline of the neck and extending well around to the left side. No thrills nor murmurs were heard over it. On August 28, 1914, the entire right lobe was removed except a small stump protecting the right inferior thyroid vessels. The tumor was very firm, very vascular and adherent, so that removal was difficult. The tumor also involved the isthmus and this was removed together with about half the left lobe.

Sections from tumor mass, although in a very young person, were found by the pathologist to correspond to one of the types of carcinoma which is well recognized as a *carcinoma*, and although seldom seen, is unquestionably a malignant growth. Dr. MacCallum corroborated this diagnosis.

As a result of this pathological report, it was deemed best to do a second operation to remove the remains of the left lobe.

Second operation, Sept. 7, 1914—Old wound opened up. Recognition of the anatomy was difficult, but remains of left lobe were identified. The inferior thyroid artery was tied and the lobe removed *in toto*.

*Pathological Report.*—Specimen consists of a portion of what appears to be the left lobe of the thyroid, attached to which is a flat bit of tissue, 4 by 2½ by 1 cm. The lobe of the thyroid appears to have normal thyroid tissue and it cuts with fairly typical resistance. The tissue attached to the lobe of the thyroid, however, cuts with much firm resistance and appears to be an infiltrating whitish, possible tumor tissue, the remains of the former carcinoma.

*Microscopic Examination.*—Left lobe of goitre shows considerable dilatation of the majority of the acini with flattening of epithelium and distention of many of them with colloid material. Portion of tumor which was left behind at first operation shows a considerable amount of dense, fibrous, connective tissue and one section shows remains of thyroid tissue in which the epithelial cells have a glandular arrangement in some cases (Fig. 11). In others they are arranged in islands infiltrating the surrounding tissue, showing no evidence of encapsulation or limiting membrane.

*Diagnosis.*—Colloid goitre, carcinoma of thyroid. Primary union.

posterior periosteum and the requisite length of rib lifted out, both ends being beveled in the sawing. This slipped nicely in place in the nose (Fig. 14), one beveled end fitting against the denuded raw frontal bone. It was seen that one graft did not lift the skin forward sufficiently, so a second piece of rib was obtained in exactly the same way and it was inserted in the nose with its raw posterior surface against the periosteum of the first graft. Fine silk interrupted sutures in skin. The oozing into the wound, resulting from the separation, was very free, so that the grafts were imbedded in a blood clot. This could not be prevented. The wound healed by primary union. The final result is good (Fig. 13). His appearance has been much improved.

### BASAL-CELL EPITHELIOMA OF THE UPPER LIP

DR. N. W. GREEN presented a man who was admitted as a private patient to St. Luke's Hospital, November 5, 1913. He was at that time forty-two years of age.

Seven years before admission he first noticed a small sore on his upper lip. This was cauterized by his family doctor and healed up upon three separate occasions, only to break out again.

On examination the upper lip upon the right side of the median line appeared to contain a buried nodule 5 mm. in diameter with its centre cleft and with the skin and mucous membrane of the lip drawn inward to this cleft forming a groove. There was no elevation of the growth. The edges of this groove were smooth and there was no ulceration (Fig. 15).

At operation this scar or groove felt hard and indurated for an area of 1 cm. in diameter. The bone was not involved and there was no glandular involvement in the near vicinity.

*Operative Procedure.*—By suitable incisions which removed the growth about  $2\frac{1}{2}$  cm. of the lip was removed, repairing the defect by a plastic around each side of the nose, and loosening up the remnants of the lip on each side and drawing them forward. Great care was taken to avoid the growth and to incise wide of it. The patient left the hospital in eighteen days with the lip healed.

The pathological report was basal-cell epithelioma of the upper lip.

*Subsequent History.*—The patient was strongly advised on leaving the hospital to have the glands at the angle of the jaw removed at the earliest date possible, but having been encouraged by erring counsel he refused to submit to this till a year later, when he was again admitted as a private patient to the hospital, and was again operated on,

## RIB GRAFT FOR SADDLE NOSE

amined with the microscope all tissues in the neighborhood of the thyroid. From each cadaver there were examined, on an average, eight pieces of tissue, and at least one or two out of these eight pieces in each body were fragments of thyroid which were indistinguishable in the gross from the parathyroid or lymphatic glands. These pieces were scattered from the base of the skull to the region of the heart, and there are a few reports of thyroid tissue in the heart muscle itself. Consequently, after the removal of the whole thyroid gland there are a considerable number of chances that some aberrant thyroid tissue remains. The old-fashioned "cachexia strumipriva" was produced by the removal of simple goitres and may have resulted so frequently in former times because of the characteristic thoroughness of a German operation. Why hyperthyroid symptoms should persist after the removal of all of a gland, as they sometimes seem to, and why myxoedema should be intensified after the same operation is very puzzling.

## RIB GRAFT FOR SADDLE NOSE

DR. CLARENCE A. MCWILLIAMS presented a man twenty-four years of age, who was struck on the bridge of nose by the hoof of a horse fifteen years ago. The nose was depressed and broken, but the doctor made no attempt to elevate it. No trouble from it now except that he desires to have a straight nose. Examination shows that the tip of the nose stands up well and normally but between the tip and the frontal bone there is a marked curve with the convexity looking backward (Fig. 12). The bridge of the nose is also very wide, as though the nasal bones had been much depressed. The operation of transplanting grafts from a rib was performed April 20, 1915, under intrapharyngeal ether administered through tubes into the mouth. A curvilinear incision was made with convexity downward just beneath the ends of the eyebrows where the crossbar of spectacles would rest. Incision carried down to bone, where transverse and vertical incisions were made through the periosteum, which was elevated for half an inch down on nose. Narrow blade of knife was passed downward, dividing the subcutaneous tissues at their attachment to the periosteum. This separation carried down almost to the tip of the nose, and outward laterally on to cheeks, until finally the skin could be sufficiently elevated to make a straight line from forehead to tip of nose. Great care was exercised not to go into nasal cavity. The right ninth rib exposed in front by a vertical incision. Transverse incisions of periosteum on upper and lower borders of rib and the periosteum separated only on the posterior surface. Gigli saw inserted between the rib and the





FIG. 15.—This shows the appearance of the lip before operation. Note the cleft or groove caused by the recession of the tissue due to growth. This is in striking contrast to the warty appearance of a growth of the lower lip.



FIG. 12.—Saddle nose before operation.



FIG. 13.—Result of implantation of a rib graft to correct the saddle deformity of the nose shown in Fig. 12.

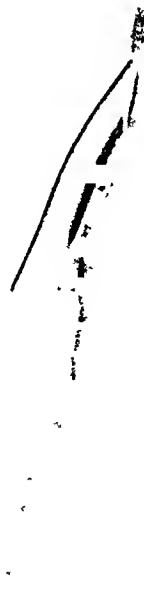


FIG. 14.—Skiagraph showing rib graft *in situ*, taken immediately after implantation in bridge of nose.

in the cosmetic result, is the placing of the incisions in the neck. Rather than the usual curved incision, joined by the one down the anterior border of the sternomastoid, the incisions here were of an angular outline carrying the transverse part of the incision well down on the neck. It greatly helps to make a better scar and prevents the "lantern jaw" appearance after these dissections.

The case has been shown largely for its pathological interest.

### SIGMOID DIVERTICULITIS

DR. WINFIELD S. SCHLEY showed a patient who was admitted May 26 last to St. Luke's Hospital. Three days before admission she was taken with generalized pain over the lower abdomen. A saline was taken, but without benefit. On the morning of admission (the third day of attack), she was given a large dose of oil. This greatly aggravated the symptoms and produced the first nausea and vomiting. She had no chills and was not conscious of fever until the day of admission. There was present frequency of urination. Patient had been well in the past except for an attack of pain in the *right* lower quadrant several months before accompanied with fever.

On admission her appearance was that of a woman acutely ill. There was moderate abdominal distention with general rigidity more marked over the left lower quadrant and midline below the umbilicus. No mass to be felt. Pelvic and rectal examination negative except for tenderness high up in cul-de-sac. The condition suggested a left-sided appendiceal abscess.

The abdomen was opened in the midline from umbilicus to pubes. Considerable fibrinous exudate and mattings of the intestine and omentum were revealed. The lower sigmoid was found hard, fixed and adherent with a dense indurated mesentery. The gut for about three inches was partly gangrenous, and for a total of *six inches indurated, fixed and in questionable condition of viability*. Resection of the sigmoid and upper two inches of rectum was done with cautery between clamps. Anastomosis at time was considered inadvisable both because of the *infection and peritonitis and condition of the patient*. Left inguinal colostomy was considered wiser. Drainage to pelvis by tube and rubber dam. Rectal end closed by inversion stitch and dropped back. This patient made a very satisfactory and uncomplicated convalescence. Colostomy opening has worked admirably, no prolapse, as gut was drawn down from above until moderately tense. Patient naturally now wants it closed. He was not greatly inclined to attempt it, as the difficulties would be unusually great from adhesions and

## BASAL-CELL EPITHELIOMA OF THE UPPER LIP

on November 27, 1914, for the left side which showed a palpable mass at the angle of the jaw, and December 11, 1914, for the right side.

The pathological findings at the time of operation for removal of the glands of the left side were as follows: On the left side in the middle of the horizontal ramus of the jaw was a hard mass about 2 cm. in diameter not encapsulated nor attached to the bone or surrounding muscle. There were several smaller nodes along the carotid sheath. The scar in the upper lip was intact and normal.

*Operative Procedure* (on the left side).—A vertical incision was made along the anterior of the sternomastoid muscle, and a more horizontal incision was made to meet it passing to the midline of the neck at the level of the hyoid bone. This was then carried upward in the midline. The lymphatic structures and the growth (metastatic) were dissected out *en masse*. The skin was then closed throughout its greatest extent save for a couple of rubber tissue drains.

*Operative Procedure* (on the right side).—Fourteen days later a similar procedure was pursued on the right side. Some of the periosteum from the jaw was removed at this time, so near was the metastasis to the bone.

Eleven days after this operation the patient was discharged with all wounds healed.

The pathological report of the material from the operation of November 27 shows the following: A mass of gland bearing tissue from the left side of the neck showed diffuse invasion of the tissue by a neoplasm of the same type as was found in the lip. A small lymph-gland, separate from the main specimen, showed inflammatory reaction, but no invasion.

The pathological report of the material from the operation of December 11, 1914, shows the following: A mass of gland bearing tissue from the right side of the neck showed no diffuse invasion, but a small lymphoid nodule adjacent to the submaxillary gland showed metastatic growth.

This case has been presented for the following reasons: First, epitheliomata of the upper lip are infrequent, while epitheliomata of the lower lip are of common occurrence. Second, the growth was frankly of the basal-cell type yet contrary to the general belief it formed metastases, similar to the original growth. Third, it indicates the direct extension from this region backward of the lymphatics to the interior of the skull, as is shown by the probable nerve root involvement, although the regions of the wounds remain clear.

The fourth point, of less interest pathologically but of some interest

urally be expected where a gall-stone had passed from the gall-bladder into the intestine by perforation of their walls.

The recovery was prompt and uneventful in spite of the patient's advanced age.

The calculus weighed 50 grammes and measured 8.6 cm. in length and 3.4 cm. in width. A small scraping showed it to be composed of cholesterin and bile pigment.

#### FOREIGN BODY, POINT OF A SCISSORS, IN THE KNEE-JOINT

DR. FRANZ TOREK presented a woman who had fallen with her knee on a scissors, which broke under the fall. She was unable to find the point of the scissors. She noticed an insignificant wound below the patella, but was not aware that the point had entered her body.

On the third day following the accident she walked to the hospital complaining of chills and of some fever and showing the site of the puncture which was apparently sealed and showed no signs of inflammation. The admitting physician ordered a röntgenogram to be taken and instructed the patient to return on the following day. This she did, again coming to the hospital on foot.

The röntgenogram is of interest, inasmuch as it shows that the point of the scissors is directed forward (see Fig. 17), although it must have gone in in the opposite direction, point first. It had therefore changed its position after it had entered the knee-joint. On opening the joint the foreign body was found exactly in the position shown by the röntgenogram, the point forward and slightly upward. The synovial fluid was turbid but not thick. A culture of this fluid proved to be sterile. After a moderate amount of cleansing the joint was closed without drainage, a procedure which did not disturb the successful outcome. The patient's highest temperature was 100.6; from the third day on it was normal. The function of the knee is perfect.

#### SESAMOID BONE IN PATELLAR LIGAMENT

DR. FRANZ TOREK presented a boy, fourteen years old, who had noticed a swelling and redness of the knee for about five weeks. He had no spontaneous pain, only a tenderness on pressure over the swelling. The accompanying röntgenogram (Fig. 18) shows in profile the condition of the knee, and the front surface of the removed specimen is shown in Fig. 19. The specimen was partly bony and partly cartilaginous. It was removed through a longitudinal incision in the middle of the tendon, the fibres of which completely covered its anterior surface and also the two lateral margins. None of the fibres were behind it. In direct relation to its posterior surface was the in-

## ILEUS DUE TO GALL-STONE

lack of fresh peritoneal surfaces, distance of separated gut ends and inflammatory thickening of mesosigmoid. He proposed sending her to the hospital for X-ray determination of intestinal position as a guide to the decision.

There were two small poutings in the sigmoid wall some three inches above the site of the resection—large calibre diverticula, so called—but not of the type which cause trouble. Hence it was decided to save this area and not extend the resection. The small probe or pin point tracts into the wall of the gut or mesentery are undoubtedly the anatomical causes of the disease.

DR. JOSEPH WIENER said that about two years ago he had a patient, a man of forty, who had an acute attack of abdominal pain, mostly on the left side; but he had a history of a possible pre-existing appendicitis; also tenderness on the right side. A consultant who was called in agreed that he probably had both appendicitis and diverticulitis.

On opening the abdomen he found a distinctly diseased appendix. He tried to pull the sigmoid into the wound but found he could not. There was an extensive diverticulitis and the walls of the sigmoid were very thin.

He turned in the wall of the sigmoid with a row of linen sutures at the site of the diverticulitis, and closed the abdomen, leaving a small drain at the lower angle. The man made a prompt recovery and he has had no return of the trouble. Judging from the appearance of the sigmoid, he would probably have had a perforation in twenty-four hours.

## ILEUS DUE TO GALL-STONE

DR. FRANZ TOREK presented a woman, seventy-six years of age, who had been admitted to the German Hospital showing the characteristic signs of ileus. She had been constipated for four days and had vomited for three days, but the most prominent symptom was cramps of extreme intensity from which she had been suffering for three days. Peristalsis was visible.

A diagnosis as to the causation of the ileus was not made. There was no previous history of gall-stones.

Operation revealed the presence of an enormous gall-stone (see Fig. 16) in the upper or middle portion of the ileum. The intestine above the stone was dilated, that below it was collapsed. The stone was held so tightly in the intestine that it could not be moved in the slightest degree. It was removed by enterotomy. In the region of the gall-bladder that organ was concealed beneath dense adhesions connecting it with the neighboring organs, a condition which would nat-



FIG. 18.—Sesamoid bone in the ligamentum patellæ. Transverse X-ray view of the affected knee-joint.



FIG. 19.—Sesamoid bone removed from the ligamentum patellæ.



FIG. 16.—Gall-stone removed from ileum on account of obstruction of bowel caused by it.



FIG. 17.—Portion of scissors blade broken off in the knee-joint.



in the pylorus had increased considerably in size. About half of the stomach was removed and the duodenum was divided as far from the tumor as possible. Omental adhesions around the stomach added to the technical difficulties. Three layers of linen sutures were used to close the stomach. The duodenum was tied off with a heavy linen ligature and two layers of linen sutures buried the stump. The omentum was sutured over the duodenal stump, and the abdomen closed without drainage. The pathological diagnosis was carcinoma. The wound healed by primary union except for a small fistula probably communicating with the duodenum. This fistula is still present. The man has gained fifteen pounds since the first operation and he is still gaining in strength.

#### APPENDICECTOMY AND COLPOPERINEORRHAPHY UNDER LOCAL ANÆSTHESIA

DR. WIENER also presented a woman in whose person he had removed the appendix and repaired the perineum under local anæsthesia.

The patient had had appendicitis for about six months. Just as he was closing up the skin wound she informed him that she had laceration of the perineum and asked if he would operate on that under the local anæsthesia. The technic for appendicectomy he had been developing for about a year. He had had fifty cases, seven acute and the others chronic. By the intelligent patients he had been assured they have had extremely little pain. One of these patients was a physician and the doctor assured him he had little or no pain and the only discomfort was the moment the cæcum was being drawn into the wound and was drawing on the mesentery. If the technic is the proper one, the pain is practically nil.

The reporter invariably, in doing the appendix operation, makes the intermuscular incision, and there is a technical reason for that. A number of men have said they tried to do it through a right rectus incision and it is not a satisfactory operation because the cæcum does not lie directly under the incision. One has to draw the small intestine toward the median line, whereas if one does an intermuscular incision, this falls away. He rarely has had to put in a packing.

In women he makes the incision down lower than in men so that if necessary he can resect the right ovary. In men he makes the incision intermuscular, but makes it somewhat higher.

DR. GEORGE WOOLSEY said that he had a case of gastric ulcer with hæmatemesis that was so exsanguinated that he did not dare give general anæsthesia and he did a gastro-enterostomy with pyloric exclusion

## GASTRO-ENTEROSTOMY UNDER LOCAL ANÆSTHESIA

frapatellar bursa, which was congested. There was no communication with the knee-joint.

The separated fibres of the patellar tendon were reunited by catgut sutures. The function of the joint is perfect.

The author has been unable, thus far, to find any reference to a similar case in the literature.

## GASTRO-ENTEROSTOMY UNDER LOCAL ANÆSTHESIA, FOLLOWED BY PYLORECTOMY UNDER ETHER

DR. JOSEPH WIENER presented a man, fifty-nine years of age, who was admitted to the First Surgical Service of Mount Sinai Hospital, September 11, 1916. His family history was unimportant, except for the fact that one sister had died of cancer. The man had always been well until three years before admission. At that time he began to complain of nausea and marked constipation. The nausea gradually grew worse and vomiting set in. Two years ago he was at the Post-Graduate Hospital for three weeks and last year he was at the Beth Israel Hospital for three weeks. At each of these hospitals he had been treated without any relief. Recently he complains of epigastric distress, nausea a few minutes after eating, followed by vomiting which gives him relief. Of late he has also been complaining of moderate pain in the back. He had not seen any blood in the vomitus or in the stools. He had lost 20 pounds in three years, and on admission weighed only 87 pounds.

On examination a small, hard, freely movable tumor was felt in the epigastrium. Owing to the extreme emaciation and poor general condition the operation was done in two stages and the first under local anæsthesia.

September 14, 1916: Posterior gastro-enterostomy; novocaine and adrenalin anæsthesia. The transverse Sprengel incision was made on the left side and a typical Moynihan gastro-enterostomy done with Connell sutures. A hard tumor the size of two walnuts was found in the pyloric region; no enlarged glands were felt, but the lumen of the pylorus was very small. The abdomen was closed without drainage. In spite of the fact that there were some omental adhesions around the stomach, the operation was done under local anæsthesia and the man complained of no pain. During the following three weeks there was some improvement in the general condition. The nausea and vomiting stopped and he gained a little in weight.

October 5, 1916: Pylorectomy under general anæsthesia. The abdomen was opened through the former site of operation. The tumor

## BOOK REVIEW

GUNSHOT INJURIES. By COLONEL LOUIS A. LAGARDE. Second revised edition. New York: William Wood & Company, 1916.

As a result of the European war the material available for a book upon this subject is enormous. There are fifteen chapters in this book dealing with technical considerations:—Characteristic lesions caused by projectiles, symptoms of gunshot wounds, infection of gunshot wounds, treatment of gunshot wounds. Gunshot wounds of the different parts of the body are taken up separately. The thirteenth chapter describes the casualties of battle. Chapter fourteen considers medicolegal phases of gunshot wounds, and the last chapter, chapter fifteen, describes the X-ray apparatus used in the field. A part of the preface to the second edition of this book gives a fairly accurate idea of what has been added to the original edition, and likewise gives a very satisfactory brief statement in the author's own words of the subjects of importance covered:

The book is a concise text-book. It proves to be interesting reading. Professor LaGarde has filled an immediate need by completing this new edition. Much will necessarily be added to subsequent editions to bring the subject up to date with the ever increasing experiences of the world war. The book is on gunshot wounds. We would like to have had thoroughly handled the treatment of fractures by splints and apparatus as used in this war in connection with both wounds and fractures. This might have taken the author too far afield. However, the treatment of the wound alone can not be apart from the apparatus for immobilization and ambulation. The book has an academic atmosphere all through. One wishes the author had gone into more detail and cited more particular cases to illustrate practical points.

CHARLES SCUDDER, M.D.

## TREATMENT OF BONY DEFECTS OF LOWER JAW

under local anæsthesia without any marked pain. The man was getting oxygen from time to time. He tried it also in another case afterwards, but although he thought he might have completed it, the traction caused so much pain that he finally gave a general anæsthetic.

The difference in the second case was that the patient was quite stout and required a great deal more traction on the posterior parietal peritoneum. It is an operation that can be done under local anæsthesia readily enough in thin patients.

DR. WINFIELD S. SCHLEY said with reference to abdominal operations under local anæsthesia that many of them are very possible after a moderate working of the technic for a short time. He had had a number of gastro-enterostomy cases under local anæsthesia. The thickness of the abdominal wall makes a great deal of difference in the ease of operation. He first tried it in major work eleven years ago, after returning home, having seen much of this work abroad. He had used novocaine with adrenalin, as he thought it had an advantage over any other local anæsthetic in that the combination diffuses remarkably from the site of injection and really does its own infiltration. After animal experimentation he found the toxicity of novocaine exactly one-sixth that of cocaine and when combined with adrenalin in small amounts it was about one-twelfth, an extremely safe and satisfactory anæsthetic agent. Personally he had relegated local anæsthesia to selected cases, those in critical condition or with organic disease, or where it is essential to shorten the period of general anæsthesia, such as in a case of an old man of, seventy-two, a neglected suppurating gall-bladder, in whom he did an entire local down to the gall-bladder and then under gas-oxygen completed the operation in about five minutes. It was astonishing how quickly the operation went and how little disturbance it caused. Local anæsthesia has distinctly a place in surgery and a field of its own in selected cases.

## THE TREATMENT OF BONY DEFECTS OF THE LOWER JAW

DR. CLARENCE A. McWILLIAMS read a paper with the above title, for which see page 283 (March).

GALL-BLADDER FILLED WITH CALCIUM CARBONATE  
PUTTY

EDITOR, ANNALS OF SURGERY,  
Brooklyn, N. Y.

DEAR SIR:

I wish to submit a report of a case of gall-stones, the interest in which attaches to the X-ray plate and the contents of the gall-bladder. The patient was a girl, 20 years of age, who since 14 years of age had suffered from dull, continuous pain in the right abdomen; at intervals attacks of vomiting with severe pain; no jaundice; at times pain below the right scapula. She has been very much troubled with catarrh of mucous membranes. One sister died from jaundice at 18 years. A second sister had an operation for gall-stones.

Patient herself was thin, frail and weak, and had tenderness over her whole right abdomen and right flank. The X-ray gave the picture shown in Fig. 1. On operation the gall-bladder was not thickened; its contents were ordinary gall-stones embedded in a putty-like mass which almost filled the gall-bladder and cystic duct, and which proved to be, on examination, pure calcium carbonate held together with a very small percentage of mucous matter.

Patient recovered quickly after gall-bladder was drained and a catarrhal appendix was removed.

In the X-ray photograph the clearer spaces represent the gall-stones.

Yours truly,

F. W. C. MOHR, M.D.,  
Ottawa, Canada.

May 2, 1917.

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To Contributors and Subscribers:

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## CORRESPONDENCE

### DEFINITION OF MAJOR AND MINOR SURGERY

A QUESTION AND AN ANSWER

ST. PAUL, MINN., April 12, 1917.

ANNALS OF SURGERY,  
Philadelphia, Penn.

DEAR SIRs:

By law the State of Minnesota permits osteopaths to practise minor surgery and prohibits them from practising major surgery. The Ramsey County Medical Society has been requested to define just what is meant by minor surgery and what is meant by major surgery. Our Society referred the question to a committee of which I am chairman.

On behalf of the Society and its committee, I wish to thank you in advance for any information which you can furnish us on the subject.

Fraternally yours,

ROBERT EARL.

April 17, 1917.

DR. ROBERT EARL,  
1014 Lowry Building,  
St. Paul, Minn.

MY DEAR DOCTOR:

Answering your letter of April 12 to the ANNALS OF SURGERY.

As its Editor, I would say that major surgery includes all work requiring a general anæsthetic; all operations which involve openings into the great cavities of the body; all operations in the course of which hazards of severe hemorrhage are possible; all conditions in which the life of the patient is at stake; all conditions which require for their relief manipulations, for the proper performance of which special anatomical knowledge and manipulative skill are essential.

I think these general statements cover pretty generally what is meant by major surgery. You will see that there is still left an abundant field for the practitioner of minor surgery.

Very truly yours,

LEWIS S. PILCHER.





FIG. 1.—Gall-stones embedded in a mass of calcium carbonate partly filling the gall-bladder.



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